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# FORTRAN Programs to Process Magsat Data for Lithospheric, External Field, and Residual Core Components

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**FORTRAN PROGRAMS TO PROCESS MAGSAT DATA FOR  
LITHOSPHERIC, EXTERNAL FIELD, AND RESIDUAL CORE  
COMPONENTS**

by

Douglas E. Alsdorf and Ralph R.B. von Frese

**ABSTRACT**

The FORTRAN programs supplied in this document provide a complete processing package for statistically extracting residual core, external field and lithospheric components in Magsat observations. The data reduction method consists of two stages involving pass-to-pass and gridded map comparisons. To process the individual passes: 1) orbits are separated into dawn and dusk local times and by altitude, 2) passes are selected based on the variance of the magnetic field observations after a least-squares fit of the core field is removed from each pass over the study area, and 3) spatially adjacent passes are processed with a Fourier correlation coefficient filter to separate coherent and non-coherent features between neighboring tracks. In the second stage of map processing: 1) data from the passes are normalized to a common altitude and gridded into dawn and dusk maps with least squares collocation, 2) dawn and dusk maps are correlated with a Fourier correlation coefficient filter to separate coherent and non-coherent features; the coherent features are averaged to produce a total field grid, 3) total field grids from all altitudes are continued to a common altitude, correlation filtered for coherent anomaly features, and subsequently averaged to produce the final total field grid for the study region, and 4) the total field map is differentially reduced to the pole. Source code which provides standard statistical information is also supplied to quantify the performance of the data reduction procedures.

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## **I. INTRODUCTION**

The National Aeronautics and Space Administration (NASA) magnetic field satellite (Magsat) has provided a global data set of geomagnetic field observations. Data retrieved from the satellite have been reviewed by NASA and made available for scientific investigations as the Chronicle and Investigator-B data sets (Langel et al., 1981). Both data sets have been used to evaluate magnetospheric effects, to define the core field and to determine magnetic anomalies at satellite altitudes associated with geologic features. The documentation and FORTRAN source code supplied in this technical memorandum describe a step by step method for processing the Investigator-B data set. The processing helps to define the magnetic anomaly field from lithospheric sources, the influence of external fields, and possible residual core field effects which are not included in current models (e.g., Alsdorf 1991).

The FORTRAN source code has been developed for processing the Investigator-B tapes. However, with adaptations the code could also be applied to the Chronicle series tapes or to other geophysical data sets (e.g., the magnetic field information from the POGO satellites). The code was developed in a UNIX-based environment on color graphics workstations such that compiled versions require user input at the terminal. Default values are noted for all user input variables, thereby facilitating the interactive nature of the processing. Graphics programs are not supplied in this document; however, the gridded data produced by the processing is formatted for standard contouring packages.

The data reduction process was broken into several steps so that modifications to the code could be more easily applied. Also, output from each step can be investigated for refinement purposes by changing the values supplied by the user. The flow chart in Figure 1 outlines each step of the data reduction process and should be referred to for the filenames described in this document. The first stage of processing operates on the individual passes while the second stage processes gridded forms of the data. For study areas covering about one fifth of the globe, it takes about two or three hours of operator

time on a RISC-based computer to generate differentially reduced-to-the-pole grids from the orbital data contained on the Investigator-B tapes. Subsequent runs through the data to adjust the variables will take less time because several of the programs need to be run only once for a study area.

A full consideration of the theoretical details of these processing procedures is beyond the scope of this report. These details are found in the references cited in the software and this report. Additional discussions and explanations can be found in Alsdorf et al. (1991; 1992).

There are six programs (Appendix B) used to process the satellite magnetic data from the individual orbits and five programs (Appendix C) that refine the data in grid form. Several auxiliary programs (Appendix D) are also provided to evaluate the output at different steps of the processing. Appendix A outlines the compile- and run-time considerations, disc storage allocation, and notes several improvements that could be made to the various programs. Chapter II describes the processing of the profiles while Chapter III details the processing of the grids.

## **II. PASS PROCESSING**

The programs used in this section include: 1) **subcore**, 2) **reorder**, 3) **massage**, 4) **movetrunc**, 5) **fourier1d** and 6) **combine**. Appendix A should be reviewed for initial set up information before executing these programs. The following programs are presented in the appropriate running order.

### **II.A SUBCORE**

After compiling each program and copying the data from the Investigator-B tapes to disc (Appendix A), the first program to run is **subcore**. This program reads the data in either sequential or direct access and writes to disc in direct access. Refer to the comment statements in the program when changing the code from the sequential access to the direct access driver. Each written record corresponds to an individual observation point as recorded by the satellite. For each record the first two values are integers (fixed point numbers) indicating the pass number and modified Julian day, respectively, and the remaining values are reals (floating point numbers) indicating location coordinates, core field values and vector magnetic field observations. NASA Technical Memorandum 82160 (Langel et al., 1981) should be consulted for a complete description of these variables. The order of the input files from the tape to disc transfer should be in the same time order as recorded by the satellite. This order will maintain the time orientation of the data which is convenient for subsequent processing. However, this rule is not absolutely necessary because program **reorder** can readjust the data to any required time or space orientation, as explained in Section II.B.

A review of the program description and comment statements in the code provides a complete assessment of the adjustments that are made to the data in **subcore**. The major functions of **subcore** are: 1) acquire only the data within user-defined latitude and longitude limits, 2) separate an individual orbit into its dawn and dusk components, and 3) calculate the core field value at each observation point. The spherical harmonic coefficients through degree and order 13 are used to model the core field and are presented in Appendix B.

After the core field value is subtracted from the observed value a series of values is written to disc. Not all of these values are necessary for future processing and some could be removed from the write statements if disc storage is limited. The subtraction of the core field from the magnetic field observations is not a profile-least-squares procedure (Alsdorf, 1991). The least-squares method of subtraction is performed in program **message** (Section II.C). After **subcore** is complete, the data files from the tape to disc transfer can be removed from disc storage because the processing no longer accesses these files.

Separate files containing dawn passes and dusk passes are written by **subcore** to disc. These files are run separately through the remaining programs that process the profiles (Figure 1).

## **II.B REORDER**

The major function of **reorder** is to rearrange the input file from a time to a spatial orientation. Ordering the passes by location in space is according either to the average longitude of a pass (the usual choice) or by the average elevation. Reordering the passes by time or pass number is also an option, however, it is seldom used. This program reads the direct access output from **subcore** and also writes out direct access files. This program requires twice the disc space as the size of the input file because it is necessary to create a working file which can be deleted after the run is complete. Once **reorder** has been completed, the 2-integer and 27-real output file from **subcore** can be deleted because the file is no longer necessary for processing.

**Subcore** and **reorder** complete the standard preliminary processing of Magsat data. The output from **reorder** should be saved, even after running further programs, because data parameters may need adjustments when refining the final output. These adjustments often include rerunning the programs described below.

## **II.C MESSAGE**

As originally designed, **message** developed a combination of local and regional models of the data in an attempt to remove external field effects by Fourier correlation coefficient filtering. This method encompasses the construction of a "guide function" which is an approximate representation of the influence of external fields in an individual



pass. The guide function and the observations are then transformed by the Fourier program (Section II.E) and wavenumber components which correlate within a user defined range of correlation coefficients are cut from the observed data. Those components which correlate represent the effects of unwanted external fields and are therefore cut from the observed spectrum. However, after many investigations it was found that bandpass filtering could provide acceptable results with less computation and disc storage requirements than the guide function method. However, the options to construct the guide function are still included in **massage** for any research that may require a cubic spline fit to the data.

The major functions of **massage** are now usually limited to the following: 1) remove "spikes" from a profile and linearly interpolate all values at latitude intervals of 0.33 degrees, 2) calculate and subtract a least-squares profile fit of the core field values from the observed values, and 3) write out two corresponding files of an individual profile where one file contains the latitude, longitude and radius (e.g., dk.llr in Figure 1) while the other file holds the magnetic field value for each interpolated observation point (e.g., dk.var). Note that output files from **massage** are sequential access and considerably smaller than previous files because each profile is marked by only one header and either three or one variable(s) depending on file type.

## II.D MOVETRUNC

This is the step where the dawn and dusk data sets are subdivided further into altitude bands (Alsdorf et al., 1992). The number and distribution of passes for each altitude band must be maintained to ensure a small distance between adjacent passes as compared to the distance to the lithosphere. For example, over the south polar region there are over 2500 dawn and dusk passes available from Magsat. After separation into four distinct altitude bands, there are over 500 passes for each local time at each altitude (Alsdorf et al., 1992), thus maintaining the density of observations for each band. Non-polar regions will have fewer passes because of the orientation of the satellite, therefore, these regions will probably have less than four altitude bands. For the purposes of this

report we will consider only two bands of altitude separation; lower and upper altitude passes. Therefore, after running **movetrunc**, four sets of data will exist including upper and lower altitude dawn data and upper and lower altitude dusk data.

Before **movetrunc** is run, the program **check** as described in Appendix D should be executed to find passes with unacceptably high variances. Also, the output file of "averaged sorted variables" from **reorder** should be copied and edited for profiles that are above or below the median elevation. Appendix A reviews the UNIX commands which can be used to create the files of pass numbers that separate the passes into upper and lower altitude sets.

**Movetrunc** reads the file of latitudes, longitudes and radii (e.g., **dk.llr**) as well as the corresponding file of magnetic field values (e.g., **dk.var**) produced from running **massage**. After removing unwanted passes, adjacent profiles are truncated to similar lengths according to the latitude value of each observation along a pass. Figure 2 schematically shows how the passes are truncated. Note that pass 6 is duplicated; one version (6w) is truncated to match the length which overlaps with pass 5 and the other version (6e) is truncated so that it has the same overlapping section as pass 7. This duplication and truncation procedure is repeated for every pass. Reviewing Figures 1 and 2, pass 6 is comparable to **dk.llr** and **dk.var**, 6w is similar to **dk.low.llr.y** and **dk.low.y**, and 6e is like **dk.low.llr.x** and **dk.low.x**. Therefore, two sets of files, offset by one pass, are written to disc so that program **fourier1d** (Section II.E) can correlate the immediately adjacent profiles.

## II.E FOURIER1D

This program performs the fast Fourier transform (FFT) and inverse FFT as well as bandwidth and/or correlation coefficient filtering. Complex number notation is used to denote the wavenumber components in the memory of the computer. Options are provided for folding out the edges of the data, smoothing the edges to zero to minimize Gibbs energy effects, and centering the data within an array of zeros. Note that the subroutines of this program are one dimensional versions of those used in **fourier2d** (Section III.B)

The following example demonstrates the size of arrays to use, the percent of data to be folded out and the percent of data to be smoothed to zero in any application. First assume that the study area has a latitude range of 40 degrees. This range results in 121 data points:

$$121 \text{ data points} = (40 \text{ degrees}) / (0.33 \text{ degrees per data point}) \quad (1)$$

The size of FFT array to use should then be set to a power of two greater than 121 data points (128 or 256). In this case 128 allows for minimal folding and smoothing, so that better performance is obtained when 256 is used. The percentage of data to be folded out can be then calculated by

$$(2 * 121 * X\%) + 121 < 256 \quad (2)$$

In using equation 2, the X percentage chosen must satisfy the less than sign. If for example we chose 10 percent, then for 121 data points, 12 values at each end of a pass will be folded out and added to the beginning or end of the profile, so that there are 145 data points ( $145 = 12 + 121 + 12$ ). The following sequence illustrates the mirror folding of data points at each end of the profile obtained by **fourier1d**.

12, 11, ... 2, 1, 1, 2, ... 11, 12, 13, ... 109, 110, 111, ... 120, 121, 121, 120, ... 111, 110

folded data ---|----- original data -----|----- folded data

The percent of data to be smoothed to zero must satisfy

$$(145 * Y\%) < 12 \quad (3)$$

where the Y percentage is chosen so that only the data folded out are smoothed and not the actual data. In this case we might chose a Y percent of 8% which smooths 11 values of each edge of 145 data points ( $11 = 0.08 * 145$ ). Finally the program will center the 145 data points within the FFT array by adding 55 zeros to the beginning and 56 zeros to the end of the 145 data points ( $55, 56 = (256 - 145) * 0.5$ ). When the final data set is written to file after inverse transforming, only the original 121 data point positions are used.

This is the first application of the **fourier1d** program and the user should consider bandpass and correlation coefficient filtering of the data at this time.

## II.F COMBINE

**Combine** is run twice when processing the data. In this first application of the

program, the two output files of latitudes, longitudes and radii (e.g., dk.low.llr.x and dk.low.llr.y) from **movetrunc** were identical except for an offset of one pass between the files. After **fourier1d** is applied in II.E, **combine** is used to find the same pass in the two files and truncate both versions of the pass to a similar length. This application of **combine** as illustrated in Figure 2 is analogous to truncating 6w and 6e so that both of these versions of pass 6 are of similar overlapping lengths. Therefore, it is important to input the files in the correct order. However, **combine** will check to see that the user has input the files correctly and if not, will stop execution of the program and issue a warning to the screen.

## II.G FOURIER1D

This is the second use of **fourier1d** on the profiles. Here, the passes should only be correlation filtered for similar wavelengths. Bandpass filtering is usually not performed.

## II.H COMBINE

This is the second use of **combine** on the profiles. The output of **combine** is chosen as one file of latitudes, longitudes, radii and anomaly values (e.g., dk.low.llra) which will be input to **collocation** as described in section III.A for gridding. This single output file is written to disc in formatted-ASCII, sequential-access so that the file may be easily transferred from a workstation to a supercomputer.

This concludes the data processing as applied to passes.

### **III. MAP PROCESSING**

Programs applied for map processing include: 1) **collocation**, 2) **fourier2d**, 3) **avgdifres**, 4) **sqrmap** and 5) **inversion**. Before executing these programs, Appendix A should be reviewed for initial set up information.

Before the programs in this chapter are run, the output file of latitudes, longitudes, radii and anomalies from **combine** (Section II.H) should be transferred from the workstation platform to a supercomputer. This transfer is not absolutely necessary, however the computing speed of a supercomputer facilitates faster processing of matrix inversions and large two-dimensional Fourier transforms.

The four sets of profile data (i.e., upper and lower altitude dawn and dusk orbits) were each processed independently as described in Chapter II. When processing the grids in this chapter, the lower altitude dawn and dusk grids are compared and the upper altitude dawn and dusk maps are compared. At the end of the processing, the lower and upper altitude total field maps can be continued to the same elevation and subsequently correlated and averaged (Alsdorf et al., 1992). The following discussion only addresses a single altitude set of dawn and dusk data, although the other altitude data will also be processed in the same manner to test for lithospheric anomaly features sets.

The program **statmat** included in Appendix D can be run using any combination of the following grids as input. **Statmat** determines a variety of standard statistics necessary for interpretation of the magnetic anomalies and the quality of processing.

The following programs are presented in correct running order.

#### **III.A COLLOCATION**

**Collocation** reads the ASCII free format file from **combine** (e.g., dk.low.llra), which includes arbitrarily distributed data points throughout the study region, and calculates node values at regular intervals over a grid at constant altitude (Goyal et al., 1991; Goyal, 1986). The output grid file from **collocation** is formatted ASCII, where the first row of values in the file is along the southern most latitude from west to east. Coordinates for the

first data point in the array are the western most longitude and the southern most latitude. The next data point is just one grid interval to the east of the first data point and along the latitude coordinate. The remaining data points in the row are successively one grid interval east of the preceding point. The next row of values follows the same west to east orientation as the first row, however this row is one grid interval to the north of the first row. The remaining rows then fill the grid successively from south to north and west to east. All programs that work with the grids keep this same orientation.

The user supplied covariance matrix (Appendix C) that is used in **collocation** has been found to produce acceptable magnetic anomalies (Goyal et al., 1991; Goyal, 1986). The covariance matrix provides a function that is used to calculate weights based on distances between grid nodes and observation points.

Both a dawn grid and a dusk grid at the same altitude are produced by separate runs of **collocation**. These grids correspond to the respective sets of passes from the profile processing. The elevation of the grids should be the same and is commonly chosen as the average elevation of all observations in the dawn and dusk data sets. **Collocation** can be used to predict values at grid points which are separated by distances of equal degrees or equal lengths. For example, when working over the polar regions, the FFT algorithms and filtering routines work best with grids of equal areas denoted by the grid coordinates of equal length separations. The program comment statements should be reviewed for appropriate input parameters when choosing between the above grid coordinate options.

### **III.B FOURIER2D**

The forward and inverse FFT subroutines of this program are the two dimensional versions of those in **fourier1d** (Section II.E). **Fourier2d** offers several data processing filters including both the bandpass and correlation coefficient routines. Additional filters are also included which are not typically used in the Magsat data processing; however, these routines are made available for expanded processing efforts. The directional filtering routine fashions a wedge-shaped filter to pass/reject directional trends of data features, whereas the remaining routines perform flat-earth upward and downward continuation, flat-earth reduction of magnetic total field anomalies to the pole, obtain flat-earth anomaly

derivatives, and adjust the phase and amplitude of the individual wavenumber components. For spherical-earth applications, both the continuation and reduction to pole of data is more suited and better constrained by the matrix inversion methods of program **inversion** (Section III.I) and, therefore, Section III.I should be reviewed for these data processing methods.

The main calling routine of **fourier2d** also differs from **fourier1d** in that it does not loop through successive profiles or maps and it allows for multiple calls to the filters in any user-defined order. The comment statements of **fourier2d** should be reviewed for the correct user input values which control the order and number of times a particular filter is called.

The dawn grid is correlated with the dusk grid such that the correlation coefficient cutoffs are set to pass the coherent and consistent anomalies. The size of the FFT array, the percent of data to be folded out and the percent of data to be smoothed are calculated in similar fashion to those of the profiles as described in Section II.E. However, because these values are applied to the columns as well as to the rows of the matrix, the various percentages will be determined by both the number of rows and columns. The input Y% should be chosen so as not to smooth actual values within the array.

This is the first use of **fourier2d** as applied to the grids and the user should only choose to apply the coefficient filter to the two grids. Alsdorf et al. (1992) review appropriate correlation cutoff values for the south polar region where the auroral external field influences are significant; other regions may require different values depending on the effects of external fields in those areas.

### **III.C AUXILIARY MAP PROCESSING**

The grid processing steps of this section are not necessary for standard map reductions; however, these steps are presented for completeness. The processing of this section removes possible external field influences manifested as coherent differences between the correlated dawn and dusk maps. Also, the standard deviations (ie. energy levels) of the correlated dawn and dusk maps are adjusted to nearly the same level.

### III.C.1 AVGDIFRES

This program can be run up to three times during the data processing; once in this auxiliary section and possibly twice in standard processing. In this initial application, **avgdifres** is used to calculate the difference between the correlated dusk and dawn grids (e.g., low.diff1).

### III.C.2 FOURIER2D

This is the second application of **fourier2d** on the grids. Here, the difference grid from **avgdifres** (e.g., low.diff1) is smoothed with a high-cut filter so that a long wavelength model of the possible influence of external fields is produced.

### III.C.3 SQRMAP

At this point, both the difference grid and its low-pass filtered version should be visually inspected to determine if the differences can serve as a model of the expected effects of external fields for the study region. If so, then **sqrmmap** subtracts the filtered difference matrix from the correlated dusk or dawn grid. Before the subtraction, the difference matrix is least-squares adjusted to more closely match the correlated dusk or dawn grid under consideration.

This concludes the auxiliary processing section.

### III.D AVGDIFRES

This is the second application of **avgdifres** to the grids. As applied here, **avgdifres** finds the average and the difference of the correlated dusk and dawn grids produced from either **fourier2d** in III.B or **sqrmmap** in III.C.3.

### III.E FOURIER2D

This is the final application of **fourier2d** to the grids. With this application the averaged grid from **avgdifres** (III.D) is high-cut filtered to remove wavelengths shorter than the elevation of the data set. Magnetic anomaly wavelengths smaller than the magnitude of the elevation of the grid are not apparent at satellite altitudes.

The high-cut filtered output map from this execution of **fourier2d** represents the total field magnetic anomaly map at the particular altitude which is being considered.



### III.F MODELING OF THE MAGNETIC ANOMALIES

The processing of the previous sections is repeated over each altitude band (e.g. both the lower and upper altitudes) producing a total field grid for each altitude. As discussed in this section, each total field grid is individually continued to a common altitude using the inversion program, then all continued grids are averaged to produce the final total field grid for the study region. This total field grid can then be differentially-reduced-to-the-pole (DRTP) for geologic interpretations and comparisons with gravitational anomalies.

#### III.F.1 AVGDIFRES

This is the final application of **avgdifres** to the grids. Here the smoothed grid from **fourier2d** (III.E) is resampled so that the output matrix can be inverted within the interactive memory allocation of a supercomputer. Generally, resampling should occur at a grid interval less than the high-cut wavelength used in **fourier2d**. This step is not necessary if precautions are taken as described below in section III.F.2.

#### III.F.2 INVERSION

This modeling program finds the effective susceptibilities which correspond to the total field grid supplied by **avgdifres** (III.F.1) or **fourier2d** (III.E) (von Frese et. al., 1981; 1988). These susceptibilities are then subjected to a core field model to produce the total field anomalies at a user defined altitude, or the susceptibilities can be subjected to a radial field of constant intensity to model the DRTP anomalies. These procedures are equivalent to spherical-earth continuation of the Magsat data. To find the susceptibilities, a core field model expanded through degree and order 13 which can be updated to the mission lifetime is necessary (e.g., Appendix B). If the subject area is large and results in more unknowns than the memory allocation of an interactive session on a supercomputer allows, then one of the following can be applied: 1) a boot strap inversion (von Frese et al., 1988), 2) the matrix inversion routines can be modified to write and read from disc rather than memory, or 3) use batch submission so that the code will be executed during a period of reduced user demand (Appendix A). Documentation in **inversion** describes cpu storage and time requirements in terms of the number of unknowns for any inversion.

After all of the total field grids are continued to an average altitude, the continued grids can be correlation filtered using **fourier2d** and subsequently averaged together to produce the final total field grid for the study area. The algorithms of the averaging code are rather straightforward, and we do not present them in this document. However, the code is available via email as outlined in Appendix A. The continued total field grids can be compared to test the self-consistency of anomaly features. Comparisons are facilitated by differencing the grids and statistical analyses.

This concludes the data processing as applied to the grids.

#### **IV. CONCLUSION**

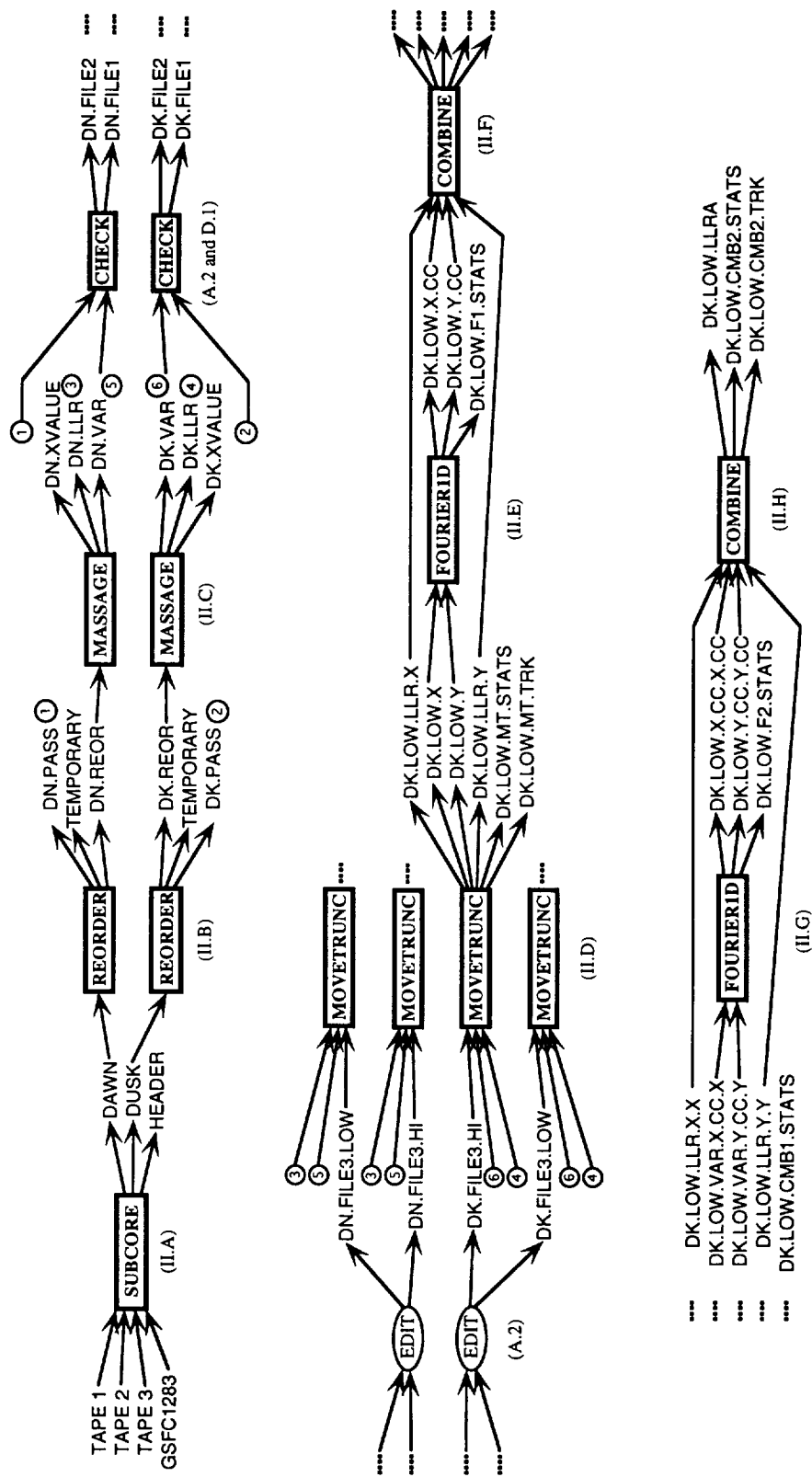
The FORTRAN programs supplied in this document provide processing capabilities for investigating lithospheric, external field, and residual core components in the Magsat data. For extracting lithospheric anomalies, the data processing begins with reading the NASA Investigator-B files and finishes with a differentially-reduced-to-the-pole magnetic anomaly map of the study region.

#### **V. ACKNOWLEDGEMENTS**

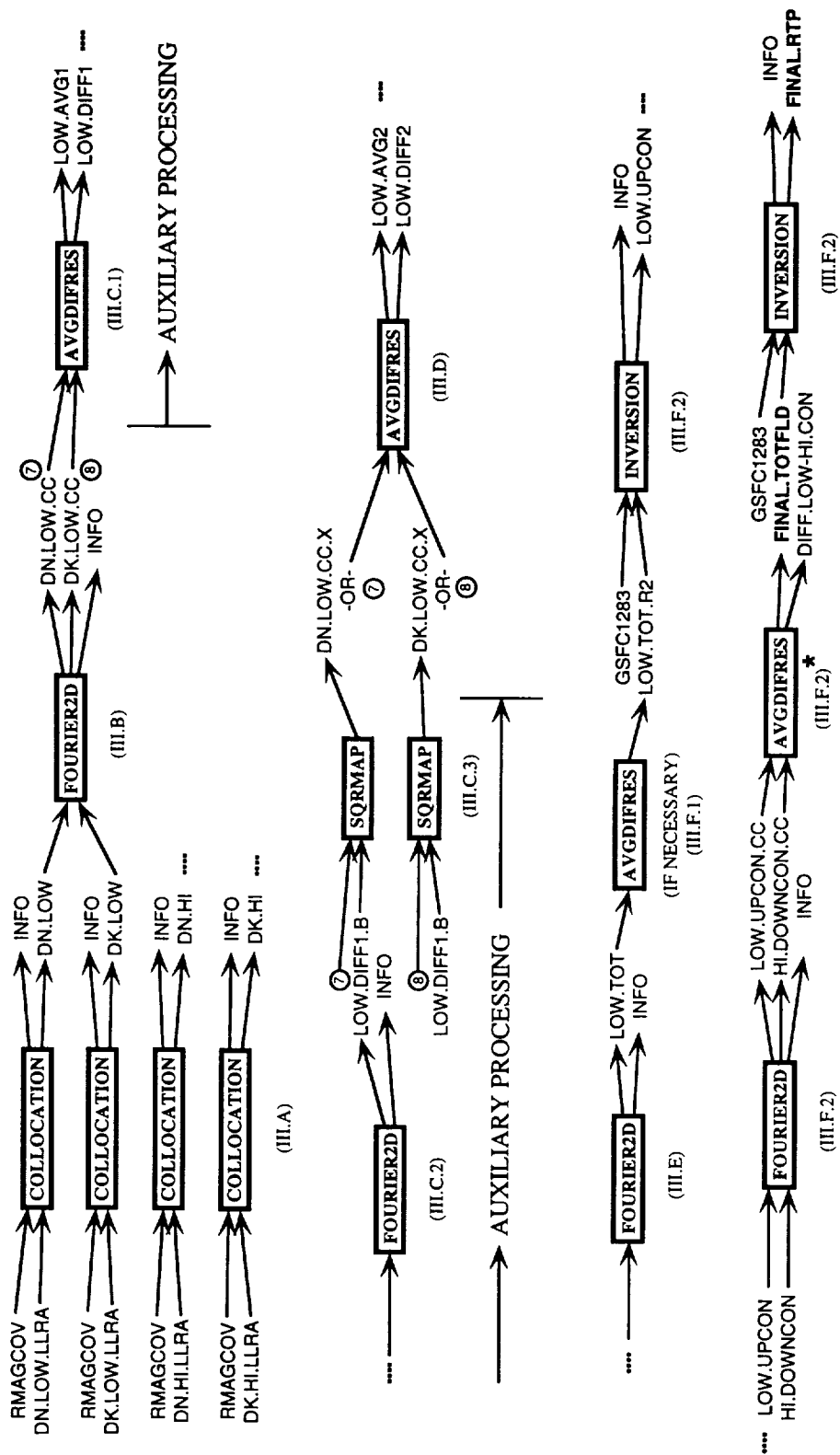
Programming advise as well as several elements of the software were provided by Drs. Dhananjay Ravat, Gary P. Murdock and Daniel R.H. O'Connell. We also thank Dr. Saul A. Teukolsky for permission to use selected FORTRAN routines from Numerical Recipes. Subroutines **spline**, **splint** and **sort** in programs **reorder**, **massage** and **check** are based on routines in Numerical Recipes in Fortran: The Art of Scientific Computing, published by Cambridge University Press and are used by permission. This memorandum originated as Geological Sciences Computing and Graphics Laboratory Report #1 of the Department of Geological Sciences at the Ohio State University. Elements of the software were developed with funding provided by the NASA Center for Mapping (NAGW-973), Amoco, Arco, Exxon, Texaco and Unocal, and the support of the Ohio Supercomputer Center. The memorandum was completed as part of a NASA Summer research fellowship to DEA at the Goddard Space Flight Center with funding from Hughes-STX.

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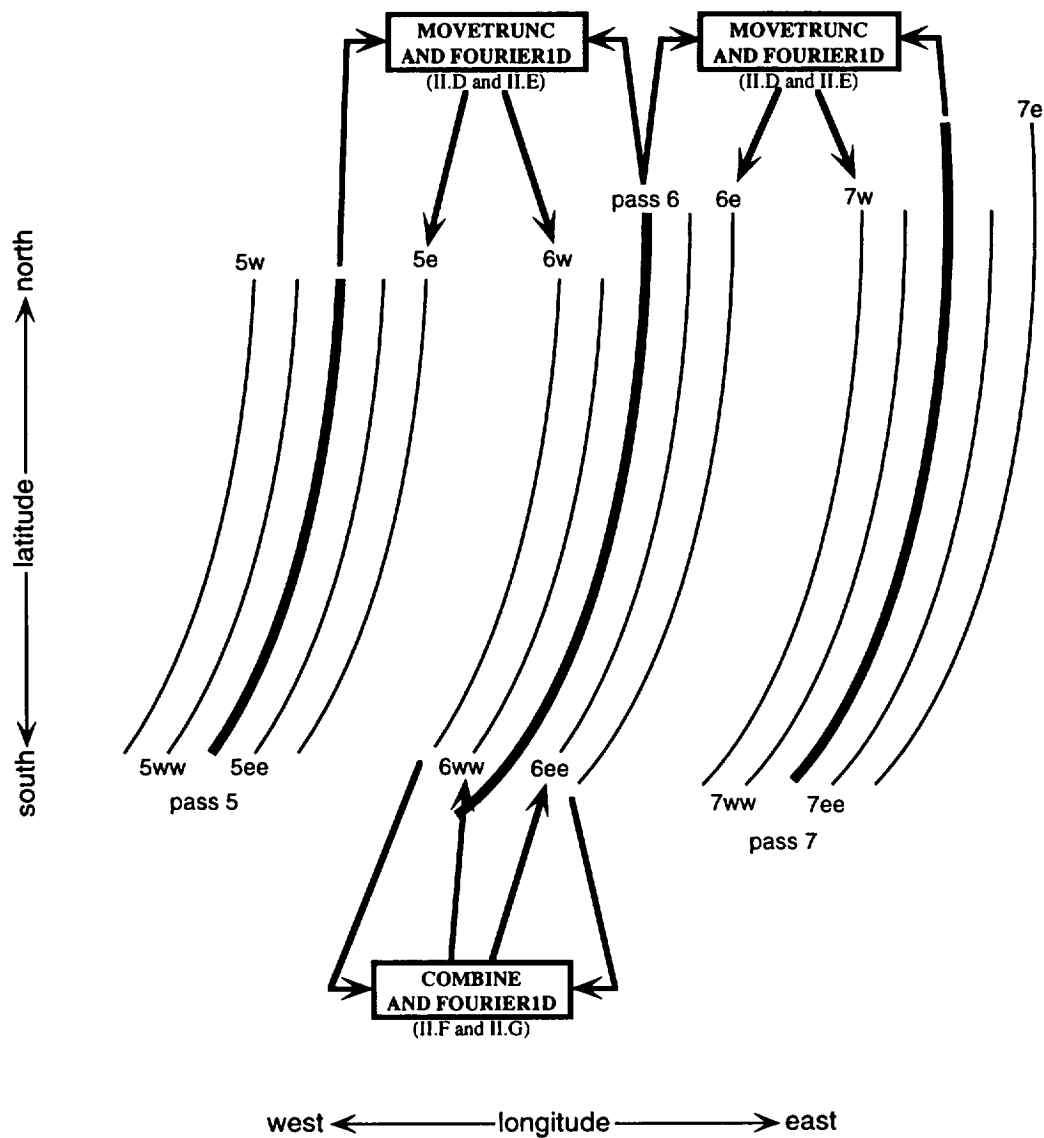


**Figure 1:** Processing flow chart. Program names are given in boxes and suggested file names follow the arrows. All names are used in the manuscript and values in parentheses are indexed to the appropriate chapter or appendix.



**Figure 1** (continued from page 17)

\* If more than two altitude bands are used, then **avgdifres** can not be used at this point. An auxiliary program to average all correlated continuations is available via email (as described in Appendix A).



**Figure 2** Pass-to-pass processing schematic showing the application of the correlation filter of program **fourier1d** and the truncation of passes by programs **movetrunc** and **combine**. Pass labeling convention follows from the text and program labels are from Figure 1.





## **APPENDIX A: DATA EDITING AND COMPUTING REQUIREMENTS**

This section describes the computing environment necessary to compile and execute the FORTRAN source code as well as disc storage estimates for the files. Additional comments address UNIX commands used to create various input files and possible improvements to the code to increase speed and decrease total file storage requirements.

### **A.1 COMPUTING ENVIRONMENT**

The source code was written, compiled and executed on DEC 3100 color graphics workstations with the Ultrix operating system. Source code in Appendix C was also compiled and executed on the Ohio Supercomputer Center's CRAY Y-MP8 which operates with UNICOS. Other computing systems with FORTRAN 77 compilers should compile, link and execute the code with little or no modifications. Programs **subcore.f**, **reorder.f** and **message.f** use direct access for file reads and writes and need to be modified for the specific operating system. The comment statements in these programs should be reviewed for additional information. After the code has been transferred to a FORTRAN source code directory, the individual programs should be compiled with the following Ultrix command:

Ultrix prompt: `f77 -static programname.f`

or with the following UNICOS command:

UNICOS prompt: `cf77 -Zp -Wf"-a static" programname.f`

The `-Zp` option allows for optimal autotasking and vectorization and `-static` permits the local variables to be statically allocated. The executable file, `a.out` created by running the FORTRAN compiler command can be moved to the users bin directory and given the same name as the programname without the `.f` extension. When executing any of the programs, the user is prompted at the screen (standard input/output device) for filenames and parameters for variables. The variables all have default values listed inside parentheses and the user can type these values as desired. Filenames are suggested in the flow chart of Figure 1.

When running the code on the CRAY, it is convenient to use the batch submission procedures for the inversion code (section III.F.2) because it may require more memory than is allocated under an interactive session. The following is a typical example of the batch submission method:

UNICOS prompt: `qsub -lM 10Mw -lT 3600 shellfile`

The `-lM 10Mw` allocates 10 megawords (80 megabytes) of memory and `-lT 3600` provides 60 minutes of cpu time to run the code in the shell file. Consult the CRAY manual pages for more information.

The total size of the three Investigator-B tapes is around 300 Megabytes (Mb) on a DEC 3100, however other machines may double the size depending on the default number of bytes used to define floating and fixed point numbers. For study areas that constitute about one fifth of the globe, disc storage requirements to run **subcore** range between 45 and 70 Mb depending on global location. To run **reorder**, 90 to 140 Mb are necessary. Between 3 and 6 Mb are needed to run any of the remaining programs in Appendix B. The dawn and dusk grids are generally less than 400 Kilobytes (Kb).

## A.2 HELPFUL UNIX COMMANDS

This section describes how to produce files of pass numbers which remove the high variance passes as well as subdivide the passes into altitude sets (e.g. lower and upper altitudes). As defined here, `file1` contains those passes with a variance above a threshold; `file2.low` and `file2.hi` hold pass numbers of either the lower or upper (respectively) altitude pass numbers; and `file3.low` and `file3.hi` include both the large variance pass numbers and the lower or upper altitude pass numbers. The following sequence of commands must be executed once for the dawn data and once again for the dusk data.

As discussed in section II.D, **check** is run immediately before **movetrunc**. Once a maximum variance cutoff has been established, **check** should be run in a UNIX script shell as follows:

```
UNIX prompt> script file1
script prompt> check
script prompt> 1 (type 1 and hit the return)
```

```
script prompt> output file from massage (e.g., dk.var)
```

```
script prompt> 1
```

```
script prompt> 200.0 200.0 200.0 -200.0 500.0
```

(these are suggested values)

```
script prompt> yes
```

```
script prompt> output file from reorder (e.g., dk.pass)
```

```
script prompt> a new file (e.g., file2)
```

Now several hundred pass numbers will be written to the screen and to file1. After the program is finished, exit out of the script shell and use a text editor to access file1.

```
script prompt> exit
```

```
UNIX prompt> vi file1 (or use any other editor)
```

Once in the editor, remove every line except those with pass numbers on them so that the final version of file1 resembles the following line.

```
1074 129 75.982 -0.023 -29.244 18.222 1087.460
```

File1 now contains the pass numbers of those passes which have a variance above the user-defined maximum (in this case  $500.0 \text{ nT}^2$ ).

Next, make two copies of file2 so that the pass numbers can be separated into low and high altitude sets.

```
UNIX prompt> cp file2 file2.low
```

```
UNIX prompt> cp file2 file2.hi
```

Edit file2.low with a text editor, removing all lines where the average elevation is above the median elevation. The median elevation occurs at the mid-line in the file (e.g., if there are 1400 lines in file2, then the median elevation occurs on line number 700). Similarly, edit file2.hi removing all lines where the average elevation is below the median elevation.

Finally, combine the edited file2.low and file2.hi with file1 as follows:

```
UNIX prompt> cat file2.low file1 > file3.low
```

```
UNIX prompt> cat file2.hi file1 > file3.hi
```

While processing the lower altitude passes, file3.hi is input to **movetrunc** when the

program asks for "input file of pass numbers not wanted". Conversely, file3.low is input to **movetrunc** when processing the upper altitude passes.

### **A.3 SUGGESTED IMPROVEMENTS**

Several improvements to the code to lower run time and decrease file sizes could be made. The following improvements concentrate on the programs that process the individual profiles as described in Appendix B:

1. **subcore:** Arrays that are in part named "data" could be combined so that the same array is passed to each subroutine.
2. **reorder:** A better method of finding the average longitude of short passes may decrease total run time.
3. **movetrunc and combine:**
  - a) These two programs are very similar and with some modifications the programs could be combined.
  - b) Because the output lat-long-radii files are similar, only one file containing flags indicating the index locations where the passes overlap is necessary for output.

The following improvements concentrate on the programs in Appendix C that process the gridded maps.

1. **collocation:**
  - a) Invert only the symmetric half of the COVM array.
  - b) Use a faster sorting routine for finding the closest points to a grid node location.
2. **inversion:** For arrays larger than the allocated machine memory, an option should be inserted that uses disc space for the matrix inversion.

As a final note, the source code is intended as a framework that allows step-wise processing of the Magsat data. This framework is open for improvements which are heartily encouraged. For copies of the code in this technical memorandum as well as additional auxiliary programs not presented in this document, send an email request to:

alsdorf@geols.mps.ohio-state.edu -or- vonfrese@geols.mps.ohio-state.edu

Comments, criticisms, suggestions for code improvements, as well as requests for code updates should also be directed to the above email addresses.

## **APPENDIX B: PROFILE PROCESSING**

### **PROGRAMS**

subcore.f

reorder.f

massage.f

movetrunc.f

fourier1d.f

combine.f

### **DATA FILE**

gsfc1283



```

program subcore
real*4 rbuff(3024/4),minlat,maxlat,minlon,maxlon,
> seconds(3000),rhead(2228/4)
integer*4 ibuff(3024/4),flag1,flag2,headcnt,recnum,
> outnum,dnum,dknum,
> dndkpass,datacnt,stop10,stop11,
> head10,data10,head11,data11,head12,data12,totrecord,
> dnrec,dkrec,nowant(50),ihead(2228/4)
character*80 filename
character*4 cbuff(3024/4),chead(2228/4)
character*60 asid
equivalence (ibuff,rbuff),(cbuff,rbuff),(flag1,ibuff(1)),
> (flag2,ibuff(2)), (ihead,rhead), (flag1,ihead(1)),
> (flag2,ihead(2)), (chead,rhead)
common /latlon/ minlat,maxlat,minlon,maxlon
common /dndkdat/ dndata(1500,26),dkdata(1500,26),
> idndata(1500,2),idkdata(1500,2)
common /coeff/ gg(50,50),ggt(50,50),ggtt(50,50),jnum,knum,
> ttzero,aaid,mmaxn,ttemp
common /mainfld/ fld(1500,8),dawn,dawni,duske,duski,dndkpass
common /thatsit/ outdawn(1500,27),outdusk(1500,27)
COMMON /NASA/ TG(50,50)
COMMON /FLDCOM/ ST,CT,SPH,CPH,R,NMAX,BT,BP,BR,B
COMMON /magfld/ THETA(1500),PHI(1500),ELVO(1500),YEAR(1500)
common data(3000,26),idata(3000,2)

c
c----- program description
c
c subcore reads the 3 NASA INVESTIGATOR-B tapes from disc and obtains
c the data for the user defined area. the program performs the following
c corrections to the data: 1) reorders the dataset from NASA's column
c arrays to user manageable row arrays 2) removes all values at a
c single sampling point if one of those values is flagged by NASA with
c 9999 3) selects the data for the user defined area 4) separates
c the area into dawn and dusk datasets 5) calculates the core-field
c value for every data point along the dawn or dusk profile and saves
c that value in an array 6) removes the core-field values from the
c data point along a dawn or dusk profile 7) removes NASA's ring-
c current correction and 8) writes several values to the output
c files - these values can be determined by looking at subroutine
c corering.
c NOTE: output unformatted files are direct access
c input unformatted files are sequential access
c output formatted files are sequential access
c NOTE: use NASA Technical Memorandum No. 82160 for a complete
c description of each variable
c
c program date: 16 apr 91
c
c updates:
c 4 jun 92, added sequential access driver
c NOTE: the input files are sequential access in this section
c to use direct access input files, then swap the
c driver at the end of the code with the currently used
c sequential access driver.
c NOTE: if you are working on an ibm rs6000 then the record
c length for direct access on files 20 and 21 is:
c recl=116
c for input of direct access to files 10,11 and 12 then
c remove the /4 from 3024/4.
c if you are working on a dec3100:
c recl=29
c and keep 3024/4.
c
c write (*,*) 'INPUT FIRST DATASET FROM TAPE TO DISC TRANSFER'
c read (*,9990) filename
9990 format (a80)
c open (10, file=filename,status='old',form='unformatted')
c write (*,*) 'INPUT SECOND DATASET FROM TAPE TO DISC TRANSFER'
c read (*,9990) filename
c open (11, file=filename,status='old',form='unformatted')
c write (*,*) 'INPUT THIRD DATASET FROM TAPE TO DISC TRANSFER'
c read (*,9990) filename
c open (12, file=filename,status='old',form='unformatted')
c write (*,*) 'INPUT FIELD MODEL SPHERICAL HARMONIC'
c write (*,*) 'COEFFICIENTS (GSFC1283)'
c read (*,9990) filename
c open (13, file=filename,status='old',form='formatted')
c----- use the following if you want to input your own nowant
c file
c write (*,*) '1 to remove certain pass numbers'
c write (*,*) '0 do no remove any pass numbers'
c read (*,*) nocnt
c if (nocnt .ne. 0) then
c write (*,*) 'input file of pass numbers not wanted'
c read (*,9990) filename
c open (14, file=filename,status='old',form='formatted')
c do i=1,5000
c read (14,*,end=10) nowant(i)
c enddo

```

```

c 10      nocnt=1-1
c      endif
c----- the following lines automatically place the nowant
c      pass numbers in the nowant array. these passes are
c      messed up for one reason or another. i'm sure they
c      could be salvaged, but i'm lazy.
      nowant(1)=909
      nowant(2)=1079
      nowant(3)=1206
      nowant(4)=2602
      nowant(5)=2728
      nowant(6)=2744
      nowant(7)=2791
      nowant(8)=2854
      nowant(9)=3059
      nocnt=9
      write (*,*) 'OUTPUT DAWN DATA FILE OF 2-INTEGERS AND 27-REALS'
      read (*,9990) filename
      open (20, file=filename,form='unformatted',access='DIRECT',
>      recl=116)
      write (*,*) 'OUTPUT DUSK DATA FILE OF 2-I AND 27-R'
      read (*,9990) filename
      open (21, file=filename,form='unformatted',access='DIRECT',
>      recl=116)
      write (*,*) 'OUTPUT HEADERS FILE'
      read (*,9990) filename
      open (22, file=filename,form='formatted')
c
      write (*,*) '0 FOR NO ADDITIONAL INFORMATION'
      write (*,*) '1 FOR ONLY Dst INDEXES'
      write (*,*) '2 FOR COMPLETE INFORMATION... this is a big file'
      read (*,*) info
      if (info.gt. 0) then
        write (*,*) 'OUTPUT ADDITIONAL INFORMATION ORBIT FILE'
        read (*,9990) filename
        open (23, file=filename,form='formatted')
      endif
c
      write (*,*) 'MINIMUM AND MAXIMUM LATITUDE OF STUDY AREA'
      write (*,*) 'INPUT RANGE IS FROM -90.0 TO 90.0'
      read (*,*) minlat,maxlat
      write (*,*) 'MINIMUM AND MAXIMUM LONGITUDE OF STUDY AREA'
      write (*,*) 'INPUT RANGE IS FROM -180.0 TO 180.0'
      read (*,*) minlon,maxlon
c
c----- the following arrays store the spherical
c      harmonic coefficients that describe the
c      core field
      READ (13,9926) Jnum,Knum,TtZERO, AaID
9926 FORMAT (2I1,1X,F6.1,A60)
      MnAXN=0
      TtEMP=0.
50 READ (13,9928) N,M,GNM,HNM,GTNM,HTNM,GTTNM,HTTNM
9928 FORMAT (2I3,6F11.4)
      IF (N.LE.0) GO TO 80
      MnAXN=(MAX0(N,MnAXN))
      Gg(N,M)=GNM
      GgT(N,M)=GTNM
      GgTT(N,M)=GTTNM
      TtEMP=AMAX1(TtEMP,ABS(GTNM))
      IF (M.EQ.1) GO TO 50
      Gg(M-1,N)=HNM
      GgT(M-1,N)=HTNM
      GgTT(M-1,N)=HTTNM
      GO TO 50
80 CONTINUE
c
      dnrec=0
      dkrec=0
      totrec=0
      datacnt=0
      headcnt=0
      stop10=0
      stop11=0
c
      head10=0
      data10=0
      recnum=1
100 num=1
      read (10,end=120) rhead
      head10=head10+1
      go to 220
c
120 stop10=1
      close (10)
      write (*,*) 'done with file one'
      write (*,*) 'total headers on file one =',head10
      write (*,*) 'total data sets on file one =',data10
      head11=0
      data11=0

```



```

        totrecord=totrecord+recnum
        recnum=1
c----- use the go to 999 statement if you only
c          want to input one file at a time
        go to 999
125  num=1
        read (11,end=150) rhead
        head11=head11+1
        go to 220
c
150  stop11=1
        close (11)
        write (*,*) 'done with file two'
        write (*,*) 'total headers on file two =',head11
        write (*,*) 'total data sets on file two =',data11
        head12=0
        data12=0
        totrecord=totrecord+recnum
        recnum=1
155  num=1
        read (12,end=999) rhead
        head12=head12+1
c
220  continue
c----- if flag1=1 then this is header file
        if (flag1 .eq. 1) then
            if (info .eq. 1) then
                write (23,*) ihead(4), (rhead(i),i=23,34)
            elseif (info .eq. 2) then
                write (23,*) (ihead(1),i=1,4), (rhead(1),i=5,8),
>                          (ihead(1),i=9,10), (rhead(1),i=11,14),
>                          (ihead(1),i=15,16), (rhead(1),i=17,34),
>                          (chead(1),i=35,64), (ihead(1),i=65,67),
>                          (rhead(1),i=68,557)
            endif
            write (22,8880) ihead(4), (rhead(i),i=5,8), (ihead(1),i=15,16)
8880  format (1x,15,4e15.7,2i6)
            dndkpass=ihead(4)
            duske=rhead(5)
            dusk1=rhead(6)
            dawn1=rhead(7)
            dawn2=rhead(8)
            headcnt=headcnt+1
            recnum=recnum+1
c
        if (flag2 .eq. 2) then
c
230  continue
c
        if (stop10.eq.0 .and. stop11.eq.0) then
            data10=data10+1
            read (10, end=120) rbuff
        elseif (stop10.eq.1 .and. stop11.eq.0) then
            data11=data11+1
            read (11, end=150) rbuff
        elseif (stop10.eq.1 .and. stop11.eq.1) then
            data12=data12+1
            read (12, end=999) rbuff
        endif
        recnum=recnum+1
        datacnt=datacnt+1
c----- if flag1=2 then this is a data file
c
        if (flag1 .eq. 1) then
>          write (*,*) 'problem with flag1 =',flag1,
>                      'in a data record'
            stop
        endif
        do i=num,num+29
            idata(1,1)=rbuff(5)
            idata(1,2)=rbuff(3)
            xnum=real(1-num)
            seconds(1)=(real(idata(1,1)) + (rbuff(6)*xnum))
        enddo
c----- these do 250 loops reorder the data
c          from column to row oriented data
        jj=7
        do 250 j=1,25
            do 250 i=num,num+29
                data(i,j)=rbuff(jj)
                jj=jj+1
250  continue
c
        num=num+30
c
c----- if flag2=1 then the next record is
c          a header and the data information is
c          complete for this orbit
        if (flag2 .eq. 1) then
            innum=num-1

```

```

c ----- search the nowant array for passes
c that just didn't happen. the
c following passes are doubled and
c are considered not wanted:
c 909,1079,1206,2602,2728,2744,2791,
c 2854,3059
c
c      do i=1,nocnt
c        if (nowant(i) .eq. idata(1,1)) then
c          write (*,*) 'removed pass number ',
>             nowant(i),idata(1,1)
c          if (stop10.eq.0 .and. stop11.eq.0) go to 100
c          if (stop10.eq.1 .and. stop11.eq.0) go to 125
c          if (stop10.eq.1 .and. stop11.eq.1) go to 155
c        endif
c      enddo
c
c      do 270 i=1,innum
c        data(i,26)=seconds(i)
270      continue
c
c      call nine (innum,outnum)
c      innum=outnum
c      call area (innum,outnum)
c      innum=outnum
c      call dawndusk (innum,dnnum,dknum)
c
c      if (dnnum .le. 0) go to 310
c      call pfligrf (dnnum,1)
c      call corering (dnnum,1)
c      do 300 i=1,dnnum
c        dnrec=dnrec+1
c        write (20,rec=dnrec) (idndata(i,j),j=1,2),
>           (outdawn(i,j),j=1,27)
300      continue
310      continue
c
c      if (dknum .le. 0) go to 360
c      call pfligrf (dknum,2)
c      call corering (dknum,2)
c      do 350 i=1,dknum
c        dkrec=dkrec+1
c        write (21,rec=dkrec) (idkdata(i,j),j=1,2),
>           (outdusk(i,j),j=1,27)
350      continue
360      continue
c
c ----- these ugly little go to's get back to a
c header record
c      if (stop10.eq.0 .and. stop11.eq.0) go to 100
c      if (stop10.eq.1 .and. stop11.eq.0) go to 125
c      if (stop10.eq.1 .and. stop11.eq.1) go to 155
c
c      endif
c ----- go back and get another data record
c      go to 230
c
c      endif
c
c      elseif (flag2 .eq. 1) then
c        write (*,*) 'a header file had no associated data record'
c        write (*,*) 'this header file has pass number ',ihead(4)
c      endif
c
c      if (stop10.eq.0 .and. stop11.eq.0) go to 100
c      if (stop10.eq.1 .and. stop11.eq.0) go to 125
c      if (stop10.eq.1 .and. stop11.eq.1) go to 155
c
c999 continue
c      write (*,*) 'total headers on file three =',head12
c      write (*,*) 'total data sets on file three =',data12
c      write (*,*) 'total headers on tapes =',headcnt
c      write (*,*) 'total data sets on tapes =',datacnt
c      totrecord=totrecord+recnum
c      write (*,*) 'total records read =',totrecord
c      write (*,*) 'total records written to dawn file =',dnrec
c      write (*,*) 'total records written to dusk file =',dkrec
c      close (12)
c      close (13)
c      close (14)
c      close (20)
c      close (21)
c      close (22)
c      close (23)
c      stop
c      end
c
c
c

```

```

      subroutine nine (innum,nincnt)
      common data(3000,26),idata(3000,2)
c
c----- subroutine description
c      this subroutine removes from the data array all variables
c      associated with a single sampling point if selected variables at
c      that sampling point are greater than 99999.0
c
      nincnt=0
c
      do 100 i=1,innum
        do j=1,3
          if (data(i,j) .ge. 99999.0) go to 200
        enddo
        do j=5,6
          if (data(i,j) .ge. 99999.0) go to 200
        enddo
        do j=8,23
          if (data(i,j) .ge. 99999.0) go to 200
        enddo
        if (idata(i,1) .ge. 9999) go to 200
c      if (data(i,1).eq.99999.0 .or. data(i,2).eq.99999.0 .or.
c      > data(i,3).eq.99999.0 .or. data(i,8).eq.99999.0 .or.
c      > data(i,12).eq.99999.0) go to 200
        nincnt=nincnt+1
        do 140 j=1,2
          idata(nincnt,j)=idata(i,j)
140      continue
        do 150 j=1,26
          data(nincnt,j)=data(i,j)
150      continue
200      continue
100    continue
c
      return
      end
c
c
c
      subroutine area(innum,outnum)
      integer*4 innum,outnum
      real*4 minlat,maxlat,minlon,maxlon
      common /latlon/ minlat,maxlat,minlon,maxlon
      common data(3000,26),idata(3000,2)
c
c----- subroutine description
c      this subroutine removes all data outside of the user defined
c      area.
c
      outnum=0
      do 200 i=1,innum
        if (data(i,1).gt.maxlat .or. data(i,1).lt.minlat .or.
        > data(i,2).gt.maxlon .or. data(i,2).lt.minlon) go to 100
        outnum=outnum+1
        do 140 j=1,2
          idata(outnum,j)=idata(i,j)
140      continue
        do 150 j=1,26
          data(outnum,j)=data(i,j)
150      continue
200      continue
c
      return
      end
c
c
c
      subroutine dawndusk (innum,dncnt,dkcnt)
      integer*4 innum,dncnt,dkcnt,totcnt
      common /dndkdat/ dndata(1500,26),dkdata(1500,26),
      > idndata(1500,2),idkdata(1500,2)
      common data(3000,26),idata(3000,2)
c
c----- subroutine description
c      this subroutine separates the data array into dawn and dusk data
c      sets.
c
      data(innum+1,1) = -90.0
      dkcnt=0
      dncnt=0
c
      do 200 i=1,innum
        if (data(i,1) .lt. data(i+1,1)) then
          dkcnt=dkcnt+1
          do 90 j=1,2
            idkdata(dkcnt,j)=idata(i,j)
90      continue
          do 100 j=1,26
            dkdata(dkcnt,j)=data(i,j)
100      continue
          do 110 j=1,26
            idndata(dncnt,j)=idata(i,j)
110      continue
          do 120 j=1,26
            dndata(dncnt,j)=data(i,j)
120      continue
          dncnt=dncnt+1
        end if
      end do
      totcnt=totcnt+dkcnt+dncnt
      return
      end

```

```

100      continue
      elseif (data(i,1) .gt. data(i+1,1)) then
        dncnt=dncnt+1
c----- remove the first "dawn" data point because
c          in reality this point could actually belong
c          to a dusk profile. a look at the longitudes
c          will prove this point. of course with some
c          extra code this point could be saved -- but
c          hey its only one in a thousand!!
c
c          if (dncnt .eq. 1) go to 160
c          do 140 j=1,2
c            idndata(dncnt-1,j)=idata(i,j)
140      continue
c          do 150 j=1,26
c            dndata(dncnt-1,j)=data(i,j)
150      continue
160      continue
      elseif (data(i,1) .eq. data(i+1,1)) then
        write (*,8880) data(i,1),data(i+1,1),idata(i,1)
8880      format ('two latitudes are equal therefore program skips',
>              /,'the first latitude ',f9.4,' and reviews the'/,
>              'second latitude ',f9.4,' for pass number',i6)
        endif
200      continue
c
c      totcnt = dkcnt + dncnt
c      if (totcnt .ne. innum) write (*,8881) dkcnt,dncnt,totcnt,innum
8881      format ('total dusk observations =',i4,' total dawn obs. =',i4,
>              /,'totals added =',i5,' which differs from the input',
>              /,'of the area selected =',i5)
c
c      dncnt=dncnt-1
c      return
c      end
c
c
c      subroutine pfligrf (innum,idndk)
c      common /dndkdat/ dndata(1500,26),dkdata(1500,26),
>              idndata(1500,2),idkdata(1500,2)
c      common /magfld/ THETA(1500),PHI(1500),ELVO(1500),YEAR(1500)
c
c*****
c
c      PROGRAM P F L I G R F
c
c      THIS PROGRAM CALCULATES VALUES OF ALL OF THE FOLLOWING ALONG
c      MAGSAT PROFILES CREATED BY STEP1P4 FORTRAN AT PURDUE.
c      INDEX      VALUE
c      1 - pass number
c      2 - TOTAL FIELD
c      3 - X COMPONENT
c      4 - Y COMPONENT
c      5 - Z COMPONENT
c      6 - INCLINATION
c      7 - DECLINATION
c      8 - latitude point to assure correct points are
c          compared
c
c      YEAR(I)=EPOCH IN YEARS AND DECIMAL FRACTION YEARS (E.G., 1965.75=
c      1 OCT. 65) FOR WHICH THE GEOMAGNETIC REFERENCE FIELD IS TO
c      BE COMPUTED AT OBSERVATION POINTS.
c      THEN THE GEOMAGNETIC FIELD OVER THE OBSER-
c      VATION POINT IS COMPUTED BY SUBROUTINE FIELDG FOR THE EPOCH
c      SPECIFIED BY THE YEAR-INPUT VARIABLE
c
c      TAPE UNITS:
c      4. (U/I).....DATA FILES CREATED BY STEP1P4
c      7. (U/O).....OUTPUT...WATCH THE ORDER OF VARIABLES
c
c      revised 25 AUG 90
c
c      this subroutine was modified to read the spherical harmonic
c      coefficients in the main program and transfer those coefficients
c      by a common block. with these modifications, the file holding the
c      coefficients is only read once and not a thousand billion times
c      which decreases total run time on the program. (ok ok, so maybe
c      not a thousand billion times, but only the number of dawn and
c      dusk profiles given to the subroutine.)
c
c      along the way i've removed some useless code that would write
c      items to file 6 or any of a number of additional places
c      depending on which format the user supplied. so if the original
c      is desired, it can be found in programs named the same as
c      the subroutines in this program.
c

```





```

C      L=0
C      WRITE (7,270) J,K,TZERO, AID
C      MAXN=0
C      TEMP=0.
C 120 READ (3,280) N,M,GNM,HNM,GTNM,HTNM,GTTNM,HTTNM
C      WRITE (7,280) N,M,GNM,HNM,GTNM,HTNM
C      IF (N.LE.0) GO TO 130
C      MAXN=(MAX0(N,MAXN))
C      G(N,M)=GNM
C      GT(N,M)=GTNM
C      GTT(N,M)=GTTNM
C      TEMP=AMAX1(TEMP,ABS(GTNM))
C      IF (M.EQ.1) GO TO 120
C      G(M-1,N)=HNM
C      GT(M-1,N)=HTNM
C      GTT(M-1,N)=HTTNM
C      GO TO 120
C 130 WRITE (7,290)
C 130 CONTINUE
C      DO 150 N=2,MAXN
C      DO 150 M=1,N
C      MI=M-1
C      IF (M.EQ.1) GO TO 140
C      WRITE (7,300) N,M,G(N,M),G(MI,N),GT(N,M),GT(MI,N),GTT(N,M),GTT(
C 1 MI,N)
C      GO TO 150
C 140 WRITE (7,310) N,M,G(N,M),GT(N,M),GTT(N,M)
C 140 CONTINUE
C 150 CONTINUE
C      WRITE (7,320)
C      IF (TEMP.EQ.0.) L=-1
C      REWIND 3
C 160 IF (K.NE.0) GO TO 190
C      SHMIT(1,1)=-1.
C      DO 170 N=2,MAXN
C      SHMIT(N,1)=SHMIT(N-1,1)*FLOAT(2*N-3)/FLOAT(N-1)
C      SHMIT(1,N)=0.
C      JJ=2
C      DO 170 M=2,N
C      SHMIT(N,M)=SHMIT(N,M-1)*SQRT(FLOAT((N-M+1)*JJ)/FLOAT(N+M-2))
C      SHMIT(M-1,N)=SHMIT(N,M)
C 170 JJ=1
C      DO 180 N=2,MAXN
C      DO 180 M=1,N
C      G(N,M)=G(N,M)*SHMIT(N,M)
C      GT(N,M)=GT(N,M)*SHMIT(N,M)
C      GTT(N,M)=GTT(N,M)*SHMIT(N,M)
C      IF (M.EQ.1) GO TO 180
C      G(M-1,N)=G(M-1,N)*SHMIT(M-1,N)
C      GT(M-1,N)=GT(M-1,N)*SHMIT(M-1,N)
C      GTT(M-1,N)=GTT(M-1,N)*SHMIT(M-1,N)
C 180 CONTINUE
C 190 T=TM-TZERO
C      DO 200 N=1,MAXN
C      DO 200 M=1,N
C      TG(N,M)=G(N,M)+T*(GT(N,M)+GTT(N,M)*T)
C      IF (M.EQ.1) GO TO 200
C      TG(M-1,N)=G(M-1,N)+T*(GT(M-1,N)+GTT(M-1,N)*T)
C 200 CONTINUE
C      TLAST=TM
C 210 DLATR=DLAT/57.2957795
C      SINLA=SIN(DLATR)
C      RLONG=DLONG/57.2957795
C      CPH=COS(RLONG)
C      SPH=SIN(RLONG)
C      IF (J.EQ.0) GO TO 220
C      R=ALT+6371.2
C      CT=SINLA
C      GO TO 230
C 220 SINLA2=SINLA**2
C      COSLA2=1.-SINLA2
C      DEN2=A2-A2B2*SINLA2
C      DEN=SQRT(DEN2)
C      FAC=((ALT*DEN)+A2)/((ALT*DEN)+B2)**2
C      CT=SINLA/SQRT(FAC*COSLA2+SINLA2)
C      R=SQRT(ALT*(ALT+2.*DEN)+(A4-A4B4*SINLA2)/DEN2)
C 230 ST=SQRT(1.-CT**2)
C      NMAX=MIN0(NMX,MAXN)
C
C      CALL FIELD
C
C      Y=BP
C      F=B
C      IF (J) 240,250,240
C 240 X=-BT
C      Z=-BR
C      RETURN
C
C      TRANSFORMS FIELD TO GEODETIC DIRECTIONS
C
C

```

```

250 SIND=SINLA*ST-SQRT(COSLA2)*CT
    COSD=SQRT(1.0-SIND**2)
    X=-BT*COSD-BR*SIND
    Z=BT*SIND-BR*COSD
    RETURN
C
260 FORMAT (2I1,1X,F6.1,A60)
270 FORMAT (2I3,5X,6HEPOCH ,F7.1,5X,A60)
280 FORMAT (2I3,6F11.4)
290 FORMAT (6H0 N M,6X,1HG,10X,1HH,9X,2HGT,9X,2HHT,8X,3HGT,8X,3HHT/
1)
300 FORMAT (2I3,6F11.4)
310 FORMAT (2I3,F11.4,11X,F11.4,11X,F11.4)
320 FORMAT (///)
C
END
C
C
C
SUBROUTINE FIELD
COMMON /NASA/ G(50,50)
COMMON /FLDCOM/ ST,CT,SPH,CPH,R,NMAX,BT,BP,BR,B
DIMENSION P(50,50), DP(50,50), CONST(50,50), SP(50), CP(50),
> FN(50), FM(50)
DATA P(1,1)/0./
C
IF (P(1,1).EQ.1.0) GO TO 120
P(1,1)=1.
DP(1,1)=0.
SP(1)=0.
CP(1)=1.
DO 110 N=2,NMAX
    FN(N)=N
DO 110 M=1,N
    FM(M)=M-1
110 CONST(N,M)=FLOAT((N-2)**2-(M-1)**2)/FLOAT((2*N-3)*(2*N-5))
120 SP(2)=SPH
CP(2)=CPH
DO 130 M=3,NMAX
    SP(M)=SP(2)*CP(M-1)+CP(2)*SP(M-1)
130 CP(M)=CP(2)*CP(M-1)-SP(2)*SP(M-1)
AOR=6371.2/R
AR=AOR**2
BT=0.
BP=0.
BR=0.
DO 190 N=2,NMAX
    AR=AOR*AR
DO 190 M=1,N
    IF (N-M) 150,140,150
140 P(N,N)=ST*P(N-1,N-1)
    DP(N,N)=ST*DP(N-1,N-1)+CT*P(N-1,N-1)
    GO TO 160
150 P(N,M)=CT*P(N-1,M)-CONST(N,M)*P(N-2,M)
    DP(N,M)=CT*DP(N-1,M)-ST*P(N-1,M)-CONST(N,M)*DP(N-2,M)
160 PAR=P(N,M)*AR
    IF (M.EQ.1) GO TO 170
    TEMP=G(N,M)*CP(M)+G(M-1,N)*SP(M)
    BP=BP-(G(N,M)*SP(M)-G(M-1,N)*CP(M))*FM(M)*PAR
    GO TO 180
170 TEMP=G(N,M)*CP(M)
    BP=BP-(G(N,M)*SP(M))*FM(M)*PAR
180 BT=BT+TEMP*DP(N,M)*AR
190 BR=BR-TEMP*FN(N)*PAR
    BP=BP/ST
    B=SQRT(BT*BT+BP*BP+BR*BR)
C
RETURN
END
C
C
C
subroutine corering (innum,idndk)
integer*4 dndkpass
common /mainfld/ fld(1500,8),dawni,dawni,duske,duski,dndkpass
common /dndkdat/ dndata(1500,26),dkdata(1500,26),
> idndata(1500,2),idkdata(1500,2)
common /thatsit/ outdawn(1500,27),outdusk(1500,27)
C
----- subroutine description
C
C this subroutine subtracts the core field at each data point and
C calculates the ring current affect as defined by NASA's formula
C which uses the E and I values for the entire orbit. this ring
C current value is also subtracted to yield the 'residual' value.
C since the total field value, the core-field value and the ring
C current values are written to file, any one value can be obtained
C at the next processing step.
C
C NOTE: the core field subtraction is not a least squares
C procedure. the least squares removal is done in
C program message

```



```

c      pie=3.1415927
      radius=6371.2
c
      if (idndk .eq. 1) then
        do 100 i=1,innum
c
          if (dndata(i,1) .ne. fld(i,8)) then
            write (*,*) 'no match between latitudes in corering',
              > ' subroutine with dawn dataset'
            write (*,*) dndata(i,1),fld(i,8)
            stop
          elseif (dndkpass.ne.idndata(i,1) .or. dndkpass.ne.fld(i,1)
            > .or. idndata(i,1).ne.fld(i,1)) then
            write (*,*) 'no match between pass numbers in corering',
              > ' subroutine with dawn dataset'
            write (*,*) dndkpass,idndata(i,1),fld(i,1)
            stop
          endif
c
          totmag=dndata(i,8)-fld(i,2)
          tavgmag=dndata(i,12)-fld(i,2)
          dip=dndata(i,6)*(pie/180.0)
          delbzz=(dawn*sin(dip))-(2.0*dawni*sin(dip)*
            > ((radius/dndata(i,3))**3.0))
          delbxx=(-1.0*dawn*cos(dip))-(dawni*cos(dip)*
            > ((radius/dndata(i,3))**3.0))
          ringcur=(sqrt(((fld(i,3)+delbxx)**2.0) + (fld(i,4)**2.0) +
            > ((fld(i,5)+delbzz)**2.0))) - fld(i,2)
          resid=totmag-ringcur
          resavgmag=tavgmag-ringcur
          do 150 j=1,15
            outdawn(i,j)=dndata(i,j)
          continue
150        do 170 j=16,21
              jj=j-14
              outdawn(i,j)=fld(i,jj)
170        continue
              outdawn(i,22)=totmag
              outdawn(i,23)=tavgmag
              outdawn(i,24)=resid
              outdawn(i,25)=resavgmag
              outdawn(i,26)=ringcur
              outdawn(i,27)=dndata(i,26)
100      continue
c
      elseif (idndk .eq. 2) then
        do 200 i=1,innum
c
          if (dkdata(i,1) .ne. fld(i,8)) then
            write (*,*) 'no match between latitudes in corering',
              > ' subroutine with dusk dataset'
            write (*,*) dkdata(i,1),fld(i,8)
            stop
          elseif (dndkpass.ne.idkdata(i,1) .or. dndkpass.ne.fld(i,1)
            > .or. idkdata(i,1).ne.fld(i,1)) then
            write (*,*) 'no match between pass numbers in corering',
              > ' subroutine with dusk dataset'
            write (*,*) dndkpass,idkdata(i,1),fld(i,1)
            stop
          endif
c
          totmag=dkdata(i,8)-fld(i,2)
          tavgmag=dkdata(i,12)-fld(i,2)
          dip=dkdata(i,6)*(pie/180.0)
          delbzz=(duske*sin(dip))-(2.0*duski*sin(dip)*
            > ((radius/dkdata(i,3))**3.0))
          delbxx=(-1.0*duske*cos(dip))-(duski*cos(dip)*
            > ((radius/dkdata(i,3))**3.0))
          ringcur=(sqrt(((fld(i,3)+delbxx)**2.0) + (fld(i,4)**2.0) +
            > ((fld(i,5)+delbzz)**2.0))) - fld(i,2)
          resid=totmag-ringcur
          resavgmag=tavgmag-ringcur
          do 250 j=1,15
            outdusk(i,j)=dkdata(i,j)
          continue
250        do 270 j=16,21
              jj=j-14
              outdusk(i,j)=fld(i,jj)
270        continue
              outdusk(i,22)=totmag
              outdusk(i,23)=tavgmag
              outdusk(i,24)=resid
              outdusk(i,25)=resavgmag
              outdusk(i,26)=ringcur
              outdusk(i,27)=dkdata(i,26)
200      continue
c
      endif
c

```

```

      return
    end

c----- this is the driver for direct access
c
c   program subcore
c   real*4 rbuff(3024/4),minlat,maxlat,minlon,maxlon,
c   > seconds(3000)
c   integer*4 ibuff(3024/4),flag1,flag2,headcnt,recnum,
c   > outnum,dnnum,dknum,
c   > dndkpass,datacnt,stop10,stop11,
c   > head10,data10,head11,data11,head12,data12,totrecord,
c   > dnrec,dkrec,nowant(50)
c   character*80 filename
c   character*4 cbuff(3024/4)
c   character*60 aaid
c   equivalence (ibuff,rbuff),(cbuff,rbuff),(flag1,ibuff(1)),
c   > (flag2,ibuff(2))
c   common /latlon/ minlat,maxlat,minlon,maxlon
c   common /dndkdat/ dndata(1500,26),dkdata(1500,26),
c   > idndata(1500,2),idkdata(1500,2)
c   common /coeff/ gg(50,50),ggt(50,50),ggtt(50,50),jnum,knum,
c   > ttzero,aaid,mmaxn,ttemp
c   common /mainfld/ fld(1500,8),dawn,dawni,duske,duski,dndkpass
c   common /thatsit/ outdawn(1500,27),outdusk(1500,27)
c   common /NASA/ TG(50,50)
c   common /FLDCOM/ ST,CT,SPH,CPH,R,NMAX,BT,BP,BR,B
c   common /magfld/ THETA(1500),PHI(1500),ELVO(1500),YEAR(1500)
c   common data(3000,26),idata(3000,2)
cc
c   write (*,*) 'INPUT FIRST DATASET FROM TAPE TO DISC TRANSFER'
c   read (*,9990) filename
c 9990 format (a80)
c   open (10, file=filename,status='old',form='unformatted',
c   > access='DIRECT',recl=3024/4)
c   write (*,*) 'INPUT SECOND DATASET FROM TAPE TO DISC TRANSFER'
c   read (*,9990) filename
c   open (11, file=filename,status='old',form='unformatted',
c   > access='DIRECT',recl=3024/4)
c   write (*,*) 'INPUT THIRD DATASET FROM TAPE TO DISC TRANSFER'
c   read (*,9990) filename
c   open (12, file=filename,status='old',form='unformatted',
c   > access='DIRECT',recl=3024/4)
c   write (*,*) 'INPUT FIELD MODEL SPHERICAL HARMONIC'
c   write (*,*) 'COEFFICIENTS (GSFC1283)'
c   read (*,9990) filename
c   open (13, file=filename,status='old',form='formatted')
cc
cc-----use the following if you want to input
cc          your own file of nowant passes
cc   write (*,*) '1 to remove certain pass numbers'
cc   write (*,*) '0 do no remove any pass numbers'
cc   read (*,*) nocnt
cc   if (nocnt .ne. 0) then
cc     write (*,*) 'input file of pass numbers not wanted'
cc     read (*,9990) filename
cc     open (14, file=filename,status='old',form='formatted')
cc     do i=1,5000
cc       read (14,*,end=10) nowant(i)
cc     enddo
cc 10    nocnt=i-1
cc   endif
cc----- the following lines automatically place the nowant
cc          pass numbers in the nowant array. these passes are
cc          messed up for one reason or another. i'm sure they
cc          could be salvaged, but i'm lazy.
c   nowant(1)=909
c   nowant(2)=1079
c   nowant(3)=1206
c   nowant(4)=2602
c   nowant(5)=2728
c   nowant(6)=2744
c   nowant(7)=2791
c   nowant(8)=2854
c   nowant(9)=3059
c   nocnt=9
c----- recl=116 for an ibm rs6000
c
c   write (*,*) 'OUTPUT DAWN DATA FILE OF 2-INTEGERS AND 27-REALS'
c   read (*,9990) filename
c   open (20, file=filename,form='unformatted',access='DIRECT',
c   > recl=29)
c   write (*,*) 'OUTPUT DUSK DATA FILE OF 2-I AND 27-R'
c   read (*,9990) filename
c   open (21, file=filename,form='unformatted',access='DIRECT',
c   > recl=29)
c   write (*,*) 'OUTPUT HEADERS FILE'
c   read (*,9990) filename
c   open (22, file=filename,form='formatted')
cc

```

```

c      write (*,*) '0 FOR NO ADDITIONAL INFORMATION'
c      write (*,*) '1 FOR ONLY Dst INDEXES'
c      write (*,*) '2 FOR COMPLETE INFORMATION... this is a big file'
c      read (*,*) info
c      if (info .gt. 0) then
c          write (*,*) 'OUTPUT ADDITIONAL INFORMATION ORBIT FILE'
c          read (*,9990) filename
c          open (23, file=filename,form='formatted')
c      endif
cc
c      write (*,*) 'MINIMUM AND MAXIMUM LATITUDE OF STUDY AREA'
c      write (*,*) 'INPUT RANGE IS FROM -90.0 TO 90.0'
c      read (*,*) minlat,maxlat
c      write (*,*) 'MINIMUM AND MAXIMUM LONGITUDE OF STUDY AREA'
c      write (*,*) 'INPUT RANGE IS FROM -180.0 TO 180.0'
c      read (*,*) minlon,maxlon
cc
cc----- the following arrays store the spherical
cc              harmonic coefficients that describe the
cc              core field
c      READ (13,9926) Jnum,Knum,TtZERO, AaID
c 9926 FORMAT (2I1,1X,F6.1,A60)
c      MmaxN=0
c      TtEMP=0.
c 50 READ (13,9928) N,M,GNM,HNM,GTNM,HTNM,GTINM,HTINM
c 9928 FORMAT (2I3,6F11.4)
c      IF (N.LE.0) GO TO 80
c      MmaxN=(MAX0(N,MmaxN))
c      Gg(N,M)=GNM
c      Ggt(N,M)=GTNM
c      Ggtt(N,M)=GTINM
c      TtEMP=AMAX1(TtEMP,ABS(GTNM))
c      IF (M.EQ.1) GO TO 50
c      Gg(M-1,N)=HNM
c      Ggt(M-1,N)=HTNM
c      Ggtt(M-1,N)=HTINM
c      GO TO 50
c 80 CONTINUE
cc
c      dnrec=0
c      dkrec=0
c      totrecord=0
c      datacnt=0
c      headcnt=0
c      stopl0=0
c      stopl1=0
cc
c      headl0=0
c      data10=0
c      recnum=1
cc
c 100 num=1
c 110 read (10,rec=recnum,err=120) rbuff
c      go to 220
cc
c 120 stopl0=1
c      write (*,*) 'done with file one'
c      write (*,*) 'total headers on file one =',headl0
c      write (*,*) 'total data sets on file one =',data10
c      headl1=0
c      data11=0
c      totrecord=totrecord+recnum
c      recnum=1
cc----- use the go to 999 statement if you only
cc              want to input one file at a time
c      go to 999
c 125 num=1
c 130 read (11,rec=recnum,err=150) rbuff
c      go to 220
cc
c 150 stopl1=1
c      write (*,*) 'done with file two'
c      write (*,*) 'total headers on file two =',headl1
c      write (*,*) 'total data sets on file two =',data11
c      headl2=0
c      data12=0
c      totrecord=totrecord+recnum
c      recnum=1
c 155 num=1
c 160 read (12,rec=recnum,err=999) rbuff
cc
c 220 continue
cc----- if flag1=1 then this is header file
c      if (flag1 .eq. 1) then
c          if (info .eq. 0) then
c              go to 225
c          elseif (info .eq. 1) then
c              write (23,*) ibuff(4), (rbuff(1),i=23,34)
c          elseif (info .eq. 2) then
c              write (23,*) (ibuff(1),i=1,4), (rbuff(1),i=5,8),

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```

c      >          (ibuff(1),1=9,10), (rbuff(1),1=11,14),
c      >          (ibuff(1),1=15,16), (rbuff(1),1=17,34),
c      >          (cbuff(1),1=35,64), (ibuff(1),1=65,67),
c      >          (rbuff(1),1=68,557)
c      endif
c 225      continue
c      write (22,8880) ibuff(4), (rbuff(1),1=5,8), (ibuff(1),1=15,16)
c 8880      format (1x,15,4e15.7,216)
c      dndkpass=ibuff(4)
c      duske=rbuff(5)
c      duski=rbuff(6)
c      dawne=rbuff(7)
c      dawni=rbuff(8)
c      headcnt=headcnt+1
c      recnum=recnum+1
c      if (stop10 .eq. 0 .and. stop11 .eq. 0) then
c          head10=head10+1
c          go to 100
c      elseif (stop10 .eq. 1 .and. stop11 .eq. 0) then
c          head11=head11+1
c          go to 125
c      elseif (stop10 .eq. 1 .and. stop11 .eq. 1) then
c          head12=head12+1
c          go to 155
c      endif
c----- if flag1=2 then this is a data file
c      elseif (flag1 .eq. 2) then
c          do 230 i=num,num+29
c              idata(1,1)=ibuff(5)
c              idata(1,2)=ibuff(3)
c              xnum=real(i-num)
c              seconds(1)=(real(ibuff(4)) + (rbuff(6)*xnum))
c 230      continue
c----- these do 250 loops reorder the data
c----- from column to row oriented data
c      jj=7
c      do 250 j=1,25
c          do 250 i=num,num+29
c              data(1,j)=rbuff(jj)
c              jj=jj+1
c 250      continue
c      num=num+30
c----- if flag2=1 then the next record is
c----- a header and the data information is
c----- complete for this orbit
c      if (flag1 .eq. 2 .and. flag2 .eq. 1) then
c          innum=num-1
c----- search the nowant array for passes
c----- that just didn't happen. the
c----- following passes are doubled and
c----- are considered not wanted:
c----- 909,1079,1206,2602,2728,2744,2791,
c----- 2854,3059
c      do i=1,nocnt
c          if (nowant(i) .eq. idata(1,1)) then
c              write (*,*) 'removed pass number ',
c                  nowant(i),idata(1,1)
c      >          go to 400
c          endif
c      enddo
c      do 270 i=1,innum
c          data(1,26)=seconds(i)
c 270      continue
c      call nine (innum,outnum)
c      innum=outnum
c      call area (innum,outnum)
c      innum=outnum
c      call dawndusk (innum,dnnum,dknum)
c      if (dnnum .le. 0) go to 310
c      call pfligrf (dnnum,1)
c      call corering (dnnum,1)
c      do 300 i=1,dnnum
c          dnrec=dnrec+1
c          write (20,rec=dnrec) (idndata(i,j),j=1,2),
c      >          (outdawn(i,j),j=1,27)
c 300      continue
c 310      continue
c      if (dknum .le. 0) go to 360
c      call pfligrf (dknum,2)
c      call corering (dknum,2)
c      do 350 i=1,dknum
c          dkrec=dkrec+1
c          write (21,rec=dkrec) (idkdata(i,j),j=1,2),

```

```

c      >                                (outdusk(1,j),j=1,27)
c 350      continue
c 360      continue
c      endif
cc
c 400      recnum=recnum+1
c          datacnt=datacnt+1
c          if (stop10 .eq. 0 .and. stop11 .eq. 0) then
c              data10=data10+1
c              go to 110
c          elseif (stop10 .eq. 1 .and. stop11 .eq. 0) then
c              data11=data11+1
c              go to 130
c          elseif (stop10 .eq. 1 .and. stop11 .eq. 1) then
c              data12=data12+1
c              go to 160
c          endif
cc
c      elseif (flag1 .ne. 1 .or. flag1 .ne. 2) then
c          write (*,*) 'HOLD THE FORT MAN, BAD FIRST FLAG NUMBER'
c          write (*,*) flag1
c          go to 999
c      endif
cc
c 999      continue
c          write (*,*) 'total headers on file three =',head12
c          write (*,*) 'total data sets on file three =',data12
c          write (*,*) 'total headers on tapes =',headcnt
c          write (*,*) 'total data sets on tapes =',datacnt
c          totrecord=totrecord+recnum
c          write (*,*) 'total records read =',totrecord
c          write (*,*) 'total records written to dawn file =',dnrec
c          write (*,*) 'total records written to dusk file =',dkrec
c          close (10)
c          close (11)
c          close (12)
c          close (13)
c          close (14)
c          close (20)
c          close (21)
c          close (22)
c          close (23)
c          stop
c          end
cc
cc----- add on all subroutines from here on

```



```

program reorder
character*80 filename
integer passmjd(4000,2),idata(400,2),istore(2),
> countall,1stop,choice,passno(4000),dndk,
> pntcnt(4000,2),shrtpas(3000,2),shrtcnt,
> passrec(4000,2),passrem,cnter,denum,pchoice,
> spknum,mincheck,spkvar,nowant(4000),outnum,
> minchk,cntsome,inrec,innum,outrec,oif,inf,onf,
> innumall,pntall(4000,2)
real data(400,27),dstore(27),east,west,diffwe,hilat,
> lolat,north,south,percent,totlat,upper,lower,
> desdata(400,27),intpdata(400,27)
double precision aver(4000,2),ra(4000),cross,passavg(4000,2),
> savglon(4000,2),crosss
common data(400,27),idata(400,2)
common /order1/ aver(4000,2),passmjd(4000,2),cross
common /order2/ passno(4000),pntcnt(4000,2),pntall(4000,2)
common /order3/ savglon(4000,2),crosss
common /hsort/ ra(4000)
common /shorty/ shrtpas(3000,2),shrtcnt,passrec(4000,2)
common /spike/ desdata(400,27),upper,lower,spkvar
common /intb/ intpdata(400,27)

c
c----- program description
c
c      this program takes data in the 2-integers and 27-reals format
c      and reorders the entire dataset into a sorted file according
c      to the variable that the user chooses. that variable is usually
c      the average longitude of each individual pass, such that after
c      reordering, the dataset will have all passes arranged from LOWEST
c      average longitude (-179.99) to the HIGHEST average longitude
c      (+179.99). if the dataset crosses the -180.0 180.0 meridian,
c      then the eastern (negative) longitudes are incremented to a
c      positive value by adding 360.0 (see write statement with
c      variable "cross"). the sorting variable can also be the
c      average elevation or the pass numbers of each individual pass
c      (sorting by pass numbers = sorting by time). this program takes
c      a little time (about 15 minutes on the DECstation 3100). the
c      program requires DIRECT ACCESS or else it just won't happen!
c      NOTE: as crazy as it may seem, real*8 is necessary for the
c      averages because i found two dusk longitude averages to be
c      EXACTLY the same with real*4. if two averages are the same
c      then passno(4000) will have the same pass twice which messes
c      up subroutine reorder2.
c      NOTE: i usually try to keep all file reads and writes in the
c      main program but reorder2 and reorder3 are a deviation
c      from the rule
c      NOTE: the dataset must be despiked and interpolated to
c      correctly calculate the longitude averages of the
c      extended passes. however, i prefer to not write out
c      the despiked or interpolated data because this program
c      represents the end of the first processing step, after-
c      which the data is ready for more involved processing
c      (ie. correlation filtering, bandpassing ...).
c      therefore, the output from reorder should be the
c      original data, only reordered. get it??
c      NOTE: for direct access on an ibm rs6000, recl=116.
c      on a dec3100, recl=29
c
c      program date: 16 apr 91
c
c      write (*,*) 'INPUT 2I-27R FILE:'
c      read (*,9990) filename
9990 format (a80)
c      open (10, file=filename, status='old',form='unformatted',
c      > access='direct',recl=116)
c      write (*,*) '0 IF THIS IS A DUSK DATASET'
c      write (*,*) '1 IF THIS IS A DAWN DATASET'
c      read (*,*) dndk
c      write (*,*) '1 TO AVERAGE AND REORDER ON LONGITUDE'
c      write (*,*) '2 TO AVERAGE AND REORDER ELEVATION'
c      write (*,*) '3 TO REORDER ON PASS NUMBER'
c      read (*,*) choice
c
c      if (choice .eq. 1) then
c      write (*,*) 'OUTPUT FILE OF 2I-27R DATASET REORDERED'
c      read (*,9990) filename
c      open (20, file=filename,form='unformatted',access='DIRECT',
c      > recl=116)
c      write (*,*) 'INTERMEDIATE I/O FILE NOT REORDERED'
c      write (*,*) '----- DO NOT USE THIS FILE -----'
c      read (*,9990) filename
c      open (21, file=filename,form='unformatted',access='direct',
c      > recl=116)
c      endif
c      if (choice .gt. 1) then
c      write (*,*) 'OUTPUT FILE OF 2I-27R DATASET REORDERED'
c      read (*,9990) filename
c      open (20, file=filename,form='unformatted',access='direct',
c      > recl=116)

```

```

endif
write (*,*) 'OUTPUT FILE OF PASS NUMBERS AND AVERAGED',
> ' SORTED VARIABLE'
read (*,9990) filename
open (22, file=filename,form='formatted')
c
write (*,*) '0 IF YOU WANT ALL PASSES'
write (*,*) '1 IF SOME PASSES NEED TO BE REMOVED'
read (*,*) pchoice
if (pchoice .eq. 1) then
write (*,*) 'INPUT FILE OF PASSES YOU DO NOT WANT'
read (*,9990) filename
open (11, file=filename,form='formatted')
endif
write (*,*) 'WHAT IS THE MINIMUM NUMBER OF'
write (*,*) 'OBSERVATIONS ALLOWABLE FOR EACH PASS (50)'
read (*,*) mincheck
c
write (*,*) '0 FOR NO DESPIKING OF DATA SET'
write (*,*) '1 FOR DESPIKING ONCE'
write (*,*) '2 FOR DESPIKING TWICE (this is the usual choice)'
write (*,*) '3 ... AND SO ON'
read (*,*) spknum
if (spknum .gt. 0) then
write (*,*) 'WHAT IS THE MAXIMUM nT: (1.0)'
write (*,*) 'WHAT IS THE MINIMUM nT: (-1.0)'
read (*,*) upper,lower
write (*,*) 'WHICH VARIABLE TO DESPIKE: (23)'
write (*,*) '1-LAT, 2-LONG,...23-totavmag..25-resavmag...'
write (*,*) 'lat lon rad mlt invlat diplat bs bv x y z'
write (*,*) 'bva xa ya za totfld xfld yfld zfld inc dec'
write (*,*) 'totmag totavmag resid resavmag ringcur sec'
read (*,*) spkvar
endif
c----- the following if statement determines if
c the study area includes the -180.0 180.0
c longitude line. for further comments see
c subroutine reorder1
cross=0.0
crosss=cross
minchk=0
if (choice .eq. 1) then
write (*,*) 'WESTERN MOST LONGITUDE OF STUDY AREA'
write (*,*) 'EASTERN MOST LONGITUDE OF STUDY AREA'
write (*,*) '-180.0 to 180.0 NOT 0.0 to 360.0'
read (*,*) west,east
diffwe = west - east
if (diffwe .gt. 0.0) then
cross=360.0
crosss=cross
write (*,*) ' '
write (*,*) 'the program has determined that this study'
write (*,*) 'area crosses the 180.0, -180.0 meridian'
write (*,*) ' '
endif
write (*,*) 'NORTHERN AND SOUTHERN MOST LATITUDES'
write (*,*) '90.0 to -90.0 NOT 0.0 to 180.0'
read (*,*) north,south
write (*,*) 'PERCENT OF TOTAL LATITUDE LENGTH TO'
write (*,*) 'TO BE CONSIDERED TO FIND SHORT PASSES (90.0)'
read (*,*) percent
c----- percent is used to calculate the range that
c is used in subroutine shorts to determine
c if a pass is a short pass or a long pass.
c see shorts for more info. also, since no
c passes go below or above 83.0 degrees, the
c program resets north and south if needed.
if (north .gt. 83.0) north = 83.0
if (south .lt. -83.0) south = -83.0
totlat=abs(north-south)
minchk=(int(((100.0-percent)/(2*100.0))*totlat)+1)*3
percent=((100.0-percent)/(2*100.0))*totlat
lolat=south+percent
hllat=north-percent
endif
c
if (minchk .gt. mincheck) then
mincheck=minchk
write (*,*) 'minimum observation cut-off increased to',
> ' ',mincheck
endif
c
if (pchoice .eq. 1) then
do 50 kk=1,4000
read (11,*,end=55) nowant(kk)
50 continue
55 continue
pchoice=kk-1
endif
c

```



```

c----- the main program reads the data to find
c          which 21-27r lines belong to a specific pass
c          number (idata(n,1)) and since it reads one line
c          of the next pass it stores that line in
c          memory.
c
c          inrec=1
c          outrec=0
c          shrtcnt=0
c          countall=0
c          jstop=0
c          passrem=0
c          cntsome=0
c
c          read (10,rec=inrec) (idata(1,i),i=1,2), (data(1,j),j=1,27)
100  n=2
105  inrec=inrec+1
      read (10,rec=inrec,err=110) (idata(n,i),i=1,2), (data(n,j),j=1,27)
      if (idata(n,1) .ne. idata(n-1,1)) go to 120
      n=n+1
      go to 105
110  continue
      jstop=1
120  continue
      do 130 i=1,2
          istore(i)=idata(n,i)
130  continue
      do 140 i=1,27
          dstore(i)=data(n,i)
140  continue
c
      countall=countall+1
      innum=n-1
      innumall=innum
c
c----- if passes are NOT wanted, remove them
      if (pchoice .eq. 0) go to 145
      do 143 ii=1,pchoice
          if (idata(innum,1) .eq. nowant(ii)) then
              write (*,*) 'PASS NUMBER REMOVED ',nowant(ii),
              > idata(innum,1)
              passrem=passrem+1
              go to 400
          endif
143  continue
145  continue
c
      if (innum .lt. mincheck) then
          write (*,9980) idata(innum,1),innum
9980  format ('PASS REMOVED AT READ =',i6,' OBSERV COUNT =',i5)
          passrem=passrem+1
          go to 400
      endif
c----- search for passes that cross from
c          -180.0 to 180.0 meridian
      imerpass=idata(1,1)
      call meridian (innum,imerpass)
c----- despike the data if user chooses and
c          despike the number of times chosen
      if (spknum .eq. 0) go to 190
      cnter=0
150  call despike (innum,denum)
      cnter=cnter+1
      innum=denum
      do 180 k=1,innum
          do 180 kk=1,27
              data(k,kk)=desdata(k,kk)
          continue
180  continue
      if (cnter .lt. spknum) go to 150
c
190  continue
      if (innum .lt. mincheck) then
          write (*,9981) idata(innum,1),innum
9981  format ('PASS REMOVED AFTER DESPIKING =',i6,
      > ' OBSERV COUNT =',i5)
          passrem=passrem+1
          go to 400
      endif
c
c----- interpolate the dataset
      call interp1 (dndk,innum,outnum)
      innum=outnum
      do 210 i=1,innum
          do 210 j=1,27
              data(i,j)=intpdata(i,j)
210  continue
      if (innum .lt. mincheck) then
          write (*,9982) idata(1,1),innum
9982  format ('PASS REMOVED AFTER INTERPOLATING =',i6,
      > ' OBSERV COUNT =',i5)

```

```

        passrem=passrem+1
        go to 400
    endif
c
    if (choice .eq. 1) oif=21
    if (choice .gt. 1) go to 260
    do 250 i=1,innum
        outrec=outrec+1
        write (oif,rec-outrec) (idata(1,j),j=1,2),(data(1,j),j=1,27)
250    continue
c
260    continue
    cntsome=cntsome+1
    pntcnt(cntsome,2)=innum
    pntcnt(cntsome,1)=idata(1,1)
    pntall(cntsome,1)=idata(1,1)
    pntall(cntsome,2)=innumall
c
c----- subroutine finds all short passes
    if (choice .eq. 1) call shorts (innum,hilat,lolat,dndk)
c
c----- now call reorder1 which will find
c----- the average longitude and elevation
c----- (not radius) and store them in
c----- aver(4000) as well as storing the
c----- pass number and modified julian day for
c----- the current pass.
    call reorder1 (innum,cntsome)
c----- ok, now go back and get more passes
c----- to average until done with the file
c
400    continue
    do 410 i=1,2
        idata(1,i)=istore(i)
410    continue
    do 420 i=1,27
        data(1,i)=dstore(i)
420    continue
    if (jstop .eq. 1) go to 500
    go to 100
c
500    continue
c
c----- now sort the chosen variable
    call sort (cntsome,choice)
c
    do 550 i=1,cntsome
        do 530 j=1,cntsome
            if (choice .eq. 1) then
                if (aver(j,choice) .eq. ra(i)) then
                    passno(i)=passmjd(j,1)
                    passavg(i,1)=db1e(passmjd(j,1))
                    passavg(i,2)=aver(j,choice)
                    write (22,*) (passmjd(j,1),ii=1,2),
>                                (aver(j,1),ii=1,2)
                go to 540
            endif
            elseif (choice .eq. 2) then
                if (aver(j,choice) .eq. ra(i)) then
                    write (22,*) (passmjd(j,1),ii=1,2),
>                                (aver(j,1),ii=1,2)
                    passno(i)=passmjd(j,1)
                    go to 540
                endif
            elseif (choice .eq. 3) then
                if (passmjd(j,1) .eq. int(ra(i))) then
                    write (22,*) (passmjd(j,1),ii=1,2),
>                                (aver(j,1),ii=1,2)
                    passno(i)=passmjd(j,1)
                    go to 540
                endif
            endif
        endif
530    continue
540    continue
550    continue
c
c----- now reread the file in reorder2 and write
c----- it ordered according to the pass numbers
c----- given to reorder2.
c
    if (choice .eq. 1) then
        inf=21
        onf=20
    elseif (choice .gt. 1) then
        inf=10
        onf=20
    endif
    call reorder2 (cntsome,inf,onf)
c
c----- if sorting by average longitude, then must

```

```

c                                     extend the shorter passes and calculate a
c                                     new average. see subroutine reorder3 for
c                                     more information.
c
c      if (choice .eq. 1) then
c
c          call reorder3 (cntsome,dndk)
c
c          do 600 i=1,cntsome
c              do 610 j=1,shrtcnt
c                  if (savglon(j,1) .eq. passavg(i,1)) then
c                      passavg(i,2)=savglon(j,2)
c                      go to 620
c                  endif
c              continue
c          610      continue
c          620      continue
c          600      ra(i)=passavg(i,2)
c          continue
c
c          call sort (cntsome,4)
c
c          write (22,*) ' '
c          write (22,*) 'new reordering as follows'
c          write (22,*) ' '
c          do 640 i=1,cntsome
c              do 650 j=1,cntsome
c                  if (ra(i) .eq. passavg(j,2)) then
c                      passno(i)=int(passavg(j,1))
c                      do 655 k=1,cntsome
c                          if (passno(i) .eq. passmjd(k,1)) then
c                              i22mjd=passmjd(k,2)
c                              x22elev=aver(k,2)
c                              go to 656
c                          endif
c                      continue
c          655      continue
c          656      continue
c                      write (22,*) int(passavg(j,1)),i22mjd,
c                          >      passavg(j,2),x22elev
c                      go to 660
c                  endif
c              continue
c          650      continue
c          660      continue
c          640      continue
c          write (22,*) ' '
c          write (22,*) shrtcnt, ' short passes as follows'
c          write (22,*) ' '
c          do 680 i=1,shrtcnt
c              write (22,*) (shrtpas(i,j),j=1,2)
c          680      continue
c
c          call reorder2 (cntsome,10,20)
c
c      endif
c
c 999 continue
c      write (*,*) 'total passes read =',countall
c      write (*,*) 'total passes written =',cntsome
c      write (*,*) 'total passes removed =',passrem
c      write (*,*) 'total passes considered to be short =',shrtcnt
c      write (*,*) 'total records read for original input file=',inrec-1
c      close (10)
c      close (20)
c      close (21)
c      close (22)
c      close (25)
c      stop
c      end
c
c
c
c      subroutine meridian (innum,passnum)
c      real data(400,27)
c      integer idata(400,2),innum,passnum
c      common data(400,27),idata(400,2)
c
c      do 100 i=1,innum-1
c          if (data(i,2) .lt. data(i+1,2)) then
c              write (*,*) passnum, ' CROSSES -180.0',data(i,2),data(i+1,2)
c              do 150 ii=1,innum
c                  if (data(ii,2) .lt. 0.0) data(ii,2)=data(ii,2)+360.0
c          150      continue
c              go to 200
c          endif
c      100      continue
c
c      200      continue
c      return
c      end
c
c
c

```

```

c      subroutine reorder1 (nobs,num)
c      real data(400,27)
c      double precision nobss,along(4000),radd(4000),aalong,aavg,selev,
>      elev(4000),savg,aver(4000,2),cross
c      integer nobs,num,idata(400,2),passmjd(4000,2),mjd,
>      passnum
c      common /order1/ aver(4000,2),passmjd(4000,2),cross
c      common data(400,27),idata(400,2)

c----- subroutine description
c
c      reorder1 takes a given set of longitudes and elevations and
c      finds the average longitude and elevation for the set. since
c      some longitudes cross FROM -180.0 TO +180.0 (that is, longitudes
c      always decrease unless crossing 180) it necessary to correct
c      the average to the more usual 360 method. therefore the
c      dataset is ordered from westernmost longitude to eastern most.
c      NOTE: real*8 is necessary since on some rare occasions the
c      averages can be the same at real*4 precision.
c      NOTE: when the study area includes the -180.0 180.0 longitude
c      line (but does not include all other longitudes) it is
c      necessary to add 360.0 to the negative (or eastern)
c      longitudes so that eastern longitudes will be located after
c      the western longitudes.
c      NOTE: for datasets that are global (ie. polar datasets or the
c      whole blasted world) then variable 'west' should be input
c      as -180.0 and variable 'east' should be input as 180.0.
c      input as such will produce a map centered on 0.0
c      longitude.
c
c      nobss=dble(nobs)
c      passnum=idata(1,1)
c      mjd=idata(1,2)
c      do 50 n=1,nobs
c          along(n)=dble(data(n,2))
c          radd(n)=dble(data(n,3))
50  continue
c
c      aalong=0.0
c      do 110 n=1,nobs-1
c          if (along(n) .lt. along(n+1)) then
c              write (*,*) passnum,' CROSSES -180.0 to 180.0',
>              along(n),along(n+1)
c              go to 130
c          endif
110  continue
c      do 120 n=1,nobs
c          aalong=aalong+along(n)
120  continue
c      aavg=aalong/nobss
c      go to 150
c
c      aalong=0.0
c      do 135 n=1,nobs
c          if (along(n) .lt. 0.0) then
c              along(n)=along(n)+360.0
c          endif
c          aalong=aalong+along(n)
135  continue
c      aavg=aalong/nobss
c
c      150  continue
c      selev=0.0
c      do 170 n=1,nobs
c          elev(n)=radd(n)-6378.140
c          selev=selev+elev(n)
170  continue
c      savg=selev/nobss
c
c      if (aavg .gt. 180.0) aavg=aavg-360.0
c      passmjd(num,1)=passnum
c      passmjd(num,2)=mjd
c      aver(num,1)=aavg + cross
c      aver(num,2)=savg
c
c      200  continue
c      return
c      end
c
c
c      subroutine reorder2 (nlines,inf,onf)
c      integer nrecord(4000),passno(4000),npoints(4000),
>      idata(2),pntcnt(4000,2),passrec(4000,2),
>      shrtpas(3000,2),shrtcnt,inrec2,inf,onf,
>      pntall(4000,2)
c      real data(27)
c      common /order2/ passno(4000),pntcnt(4000,2),pntall(4000,2)
c      common /shorty/ shrtpas(3000,2),shrtcnt,passrec(4000,2)

```

```
c----- the basis for this subroutine was provided
c               quite generously
c               by:      Dr. D.R.H. O'Connell
c                       Dept. of Geological Sci.
c                       Ohio State University
c----- determine which pass this point belongs to.
c
c       if (inf .eq. 10) then
c         do 20 i=1,nlines
c           passrec(i,1)=passno(i)
c           do 30 ii=1,nlines
c             if (passno(ii) .eq. pntall(ii,1)) then
c               npoints(i)=pntall(ii,2)
c               go to 35
c             endif
c           continue
c         continue
c       20    continue
c       elseif (inf .eq. 21) then
c         do 50 i=1,nlines
c           passrec(i,1)=passno(i)
c           do 40 ii=1,nlines
c             if (passno(ii) .eq. pntcnt(ii,1)) then
c               npoints(i)=pntcnt(ii,2)
c               go to 45
c             endif
c           continue
c         40    continue
c         45    continue
c       50    continue
c     endif
c----- npoints = number of records to allocate
c----- for each pass number. nrecord = the output file
c----- record positions for each pass
c
c       nrecord(1)=1
c       passrec(1,2)=1
c       do 60 i=2,nlines
c         ii=i-1
c         nrecord(i)=nrecord(ii)+npoints(ii)
c         passrec(i,2)=nrecord(i)
c       60    continue
c----- read each data point
c
c       rewind (inf)
c       inrec2=0
c       70    inrec2=inrec2+1
c       read (inf,rec=inrec2,err=90) (ldata(j),j=1,2),(data(k),k=1,27)
c----- determine the matching pass number and its
c----- output record number by searching all pass numbers
c
c       do 80 i=1,nlines
c         if (ldata(1) .eq. passno(i)) then
c           * write (onf,rec=nrecord(i))
c             (ldata(j),j=1,2),(data(k),k=1,27)
c         *
c       80    nrecord(i)=nrecord(i)+1
c----- increment output record number for this pass number
c----- read next data point
c
c       goto 70
c     endif
c   80    continue
c   90    go to 70
c   90    continue
c
c   write (*,*) inrec2 - 1,' TOTAL RECORDS READ FOR FILE',inf
c   write (*,*) nrecord(nlines)-1,' TOTAL RECORDS WRITTEN',
c >          ' FOR FILE',onf
c----- webe jammin
c
c   return
c end
c
c
c
c
c SUBROUTINE SORT(N,choice)
c double precision ra(4000),aver(4000,2),rra,cross
c integer passmjd(4000,2),n,choice
c common /order1/ aver(4000,2),passmjd(4000,2),cross
c common /hsort/ ra(4000)
c-----this subroutine is written by the authors
c               of: Numerical Recipes (fortran);
c                   The Art of Scientific Computing
c                   Cambridge University Press
c                   1989, p. 230
c               the routine is referred to as "heapsort"
c Copyright (C) 1986, 1992 Numerical Recipes Software
c if (choice .le. 2) then
c   do 10 i=1,n
c     ra(i)=aver(i,choice)
```

```

10      continue
      elseif (choice .eq. 3) then
        do 30 i=1,n
          ra(i)=dble(passmjd(i,1))
30      continue
      endif
c
      L=N/2+1
      IR=N
100     CONTINUE
      IF (L.GT.1) THEN
        L=L-1
        RRA=RA(L)
      ELSE
        RRA=RA(IR)
        RA(IR)=RA(1)
        IR=IR-1
        IF (IR.EQ.1) THEN
          RA(1)=RRA
          RETURN
        ENDIF
      ENDIF
      I=L
      J=L+L
200     IF (J.LE.IR) THEN
       IF (J.LT.IR) THEN
         IF (RA(J).LT.RA(J+1)) J=J+1
       ENDIF
       IF (RRA.LT.RA(J)) THEN
         RA(I)=RA(J)
         I=J
         J=J+J
       ELSE
         J=IR+1
       ENDIF
       GO TO 200
     ENDIF
     RA(I)=RRA
     GO TO 100
  END
c
c
c
c      subroutine shorts (innum,hilat,lolat,dndk)
c      integer innum,idata(400,2),dndk,shrtcnt,
c      >      shrtpas(3000,2),passrec(4000,2)
c      real data(400,27),hilat,lolat
c      common data(400,27),idata(400,2)
c      common /shorty/ shrtpas(3000,2),shrtcnt,passrec(4000,2)
c
c      ----- subroutine description
c      shorts determines if the pass is short. a short pass is
c      a pass which does not extend above the northern-most
c      (hilat) or below the southern-most (lolat).
c
c      if (dndk .eq. 0) then
c        if (data(1,1) .gt. lolat .or.
c      >      data(innum,1) .lt. hilat) then
c          shrtcnt=shrtcnt+1
c          shrtpas(shrtcnt,1)=idata(1,1)
c          shrtpas(shrtcnt,2)=innum
c        endif
c      elseif (dndk .eq. 1) then
c        if (data(innum,1) .gt. lolat .or.
c      >      data(1,1) .lt. hilat) then
c          shrtcnt=shrtcnt+1
c          shrtpas(shrtcnt,1)=idata(1,1)
c          shrtpas(shrtcnt,2)=innum
c        endif
c      endif
c
c      return
c      end
c
c
c
c      subroutine reorder3 (allcnt,dndk)
c      integer shrtpas(3000,2),shrtcnt,passrec(4000,2),
c      >      allcnt,passnum,recnum,row,recnt,rrow,frow,
c      >      isdata(400,2),frec,nrec,rrec,pass,ifdata(400,2),
c      >      irdata(400,2),numcnt,minrrow,stocount,minfrow,
c      >      dndk,fcnt,rcnt
c      real sdata(400,2),fdata(400,2),rdata(400,2),sftdat(400,2),
c      >      ftdata(400,2),rtdata(400,2),totfdiff,totrdiff,
c      >      fdiff,rdiff,totsft,totsrt,srtat(400,2)
c      double precision avgsilon,avggrdiff,avgfdiff,savglon(4000,2),crosss
c      common /shorty/ shrtpas(3000,2),shrtcnt,passrec(4000,2)
c      common /trunc/ sdata(400,2),fdata(400,2),rdata(400,2),
c      >      sftdat(400,2),ftdata(400,2),srtat(400,2),
c      >      rtdata(400,2)

```

```

common /order3/ savglon(4000,2),crosss
c
c-----subroutine description
c      this subroutine extends all short passes by adding or subtracting
c      the average longitude difference from the closest full length
c      pass, then calculates the true average longitude for the short
c      pass, and stores that true average in an array. the short passes
c      are found by subroutine shorts with a user defined percentage of total
c      length to be considered as a long pass. as this percentage is
c      increased the distance to the closest pass also increases such that
c      there is more chance for error due to a poor fit of the average
c      longitude. the closest full length pass is either west or east
c      of the short pass. if west, then the average difference is added
c      to the full length pass, however, if east then the average
c      difference is subtracted. these values are then added to the
c      longitudes of the short pass to create a set of full length
c      longitudes which are averaged together to get the true average
c      longitude. the fundamental principle involved here is that passes
c      are always parallel and do not actually cross over each other.
c      therefore, the difference between adjacent passes remains almost
c      -or at least pretty dog-gone close to almost- constant.
c
c
c      icnt=1
c      continue
50  do 100 i=1,allcnt
c      if (shrtpas(icnt,1) .eq. passrec(i,1)) then
c          recnum=passrec(i,2)
c          passnum=passrec(i,1)
c          row=shrtpas(icnt,2)
c          recnt=i
c          go to 200
c      endif
100  continue
c
200  continue
c----- read in the short pass
c      do 220 i=1,row
c          read (20,rec=recnum) (isdata(i,j),j=1,2),(sdata(i,j),j=1,2)
c          recnum=recnum+1
220  continue
c      recnum=recnum-1
c      if (passnum .ne. isdata(row,1)) then
c          write (*,*) 'wrong pass number in reorder3'
c          stop
c      endif
c----- add 360.0 to longitudes that cross the
c      -180.0 to 180.0 meridian so that averages
c      are correct
c      do 230 n=1,row-1
c          if (sdata(n,2) .lt. sdata(n+1,2)) then
c              do 235 i=1,row
c                  if (sdata(i,2) .lt. 0.0) sdata(i,2)=sdata(i,2)+360.0
235          continue
c              go to 238
c          endif
230  continue
238  continue
c
c----- find the starting record number for the
c      nearest east pass
c      frec=0
c      numcnt=recnt+1
c      if (numcnt .gt. allcnt) go to 270
c      nrec=passrec(numcnt,2)
240  continue
c      read (20,rec=nrec) pass
c      do 260 i=1,shrtcnt
c          if (pass .eq. shrtpas(i,1)) then
c              numcnt=numcnt+1
c              if (numcnt .gt. allcnt) go to 270
c              nrec=passrec(numcnt,2)
c              go to 240
c          endif
260  continue
c      frec=nrec
c
c----- find the starting record number for the
c      nearest west pass
270  continue
c      rrec=0
c      numcnt=recnt-1
c      if (numcnt .lt. 1) go to 300
c      nrec=passrec(numcnt,2)
280  continue
c      read (20,rec=nrec) pass
c      do 290 i=1,shrtcnt
c          if (pass .eq. shrtpas(i,1)) then
c              numcnt=numcnt-1
c              if (numcnt .lt. 1) go to 300

```

```

        nrec=passrec(numcnt,2)
        go to 280
    endif
290 continue
    rrec=nrec
c----- calculate the average longitude
c
300 continue
    avgfdiff=10000.0
    if (frec .gt. 0) then
        i=1
        > read (20,rec=frec,err=340) (ifdata(i,j),j=1,2),
            (fdata(i,j),j=1,2)
        i=i+1
        frec=frec+1
320 > read (20,rec=frec,err=340) (ifdata(i,j),j=1,2),
            (fdata(i,j),j=1,2)
        if (ifdata(i-1,1) .ne. ifdata(i,1)) go to 340
        frec=frec+1
        i=i+1
340 go to 320
        continue
        frow=i-1
        do 344 n=1,frow-1
            if (fdata(n,2) .lt. fdata(n+1,2)) then
                do 342 i=1,frow
                    if (fdata(i,2) .lt. 0.0) fdata(i,2)=fdata(i,2)+360.0
342 continue
                    go to 345
                endif
            endif
        continue
344 continue
345 continue
c----- truncate the short and forward passes
c----- to the same length
c
        > call truncate (row,frow,dndk,minfrow,stocount,passnum,
            ifdata(frow,1),1)
        totfdiff=0.0
        totsft=0.0
        do 350 i=1,minfrow
            fdiff=abs(sftdat(i,2)-ftdata(i,2))
            totfdiff=fdiff+totfdiff
            totsft=totsft+sftdat(i,2)
350 continue
c----- calculate the average longitude difference
        avgfdiff=dble(totfdiff/real(minfrow))
    endif
c
c----- repeat the process for the closest west pass
c
    avgrdiff=10000.0
    if (rrec .gt. 0) then
        i=1
        read (20,rec=rrec) (irdata(i,j),j=1,2), (rdata(i,j),j=1,2)
        i=i+1
        rrec=rrec+1
360 read (20,rec=rrec) (irdata(i,j),j=1,2), (rdata(i,j),j=1,2)
        if (irdata(i-1,1) .ne. irdata(i,1)) go to 380
        rrec=rrec+1
        i=i+1
        go to 360
        continue
380 rrow=i-1
        do 384 n=1,rrow-1
            if (rdata(n,2) .lt. rdata(n+1,2)) then
                do 382 i=1,rrow
                    if (rdata(i,2) .lt. 0.0) rdata(i,2)=rdata(i,2)+360.0
382 continue
                    go to 385
                endif
            endif
        continue
384 continue
385 call truncate (row,rrow,dndk,minrrow,stocount,passnum,
        > irdata(rrow,1),-1)
        totrdiff=0.0
        totsrt=0.0
        do 390 i=1,minrrow
            rdif=abs(srtat(i,2)-rtdata(i,2))
            totrdiff=rdif+totrdiff
            totsrt=totsrt+srtat(i,2)
390 continue
        avgrdiff=dble(totrdiff/real(minrrow))
    endif
c
c----- if the east difference is the smallest
c----- then use the east pass to calculate
c----- average longitude of the extended short
c----- pass
    if (avgfdiff .lt. avgrdiff) then
        do 400 i=1,frow
            if (ftdata(i,2) .eq. fdata(i,2)) then

```





```

c----- subroutine description
c      truncate compares the input passes and truncates both
c      passes to the same overlapping length.
c
c      do 20 j=1,xrow
c          do 20 jj=1,2
c              xdata(j,jj)=sdata(j,jj)
20      continue
c      if (fr) 50,50,60
50      do 55 j=1,yrow
c          do 55 jj=1,2
c              ydata(j,jj)=rdata(j,jj)
55      continue
c      go to 80
60      do 65 j=1,yrow
c          do 65 jj=1,2
c              ydata(j,jj)=fdata(j,jj)
65      continue
c
c      80      continue
c          stocount=0
c          jj=1
c          rowli=xrow
c          rowinc=yrow
c----- loops from 90 to 200 increment through the
c          two input passes and truncate the lengths
c          to the same length
90      continue
c          adata=xdata(jj,1)
c          bdata=ydata(jj,1)
c          diffab=adata-bdata
c          abss=abs(diffab)
c          if (rowli .eq. 0 .or. rowinc .eq. 0) then
c----- if this happens, then the findgap subroutine from
c          movetrunc will have to be implemented to remove
c          the appropriate pass. so far, there hasn't been
c          any problems. another alternative would be to
c          use only the east or west pass instead of
c          comparing both to the short pass.
c
c          write (*,*) 'xrows (s) =',rowli,' yrows (',fr,') =',rowinc
c          write (*,*) 'big problem with pass number =',xpassno,ypassno
c          write (*,*) 'xrow =',xrow,' yrow =',yrow
c          stop
c      endif
c      minrow=min(rowli,rowinc)
c----- if pass a (li) matches pass b (inc) at
c          beginning length then write to xdata and
c          ydata and race to main program
c
c      if (abss .lt. 0.33) then
c          if (fr .eq. -1) then
c              do 110 ll=1,minrow
c                  do 110 kk=1,2
c                      srtdata(ll,kk)=xdata(ll,kk)
c                      rtdata(ll,kk)=ydata(ll,kk)
110          continue
c          elseif (fr .eq. 1) then
c              do 115 ll=1,minrow
c                  do 115 kk=1,2
c                      sftdata(ll,kk)=xdata(ll,kk)
c                      ftdata(ll,kk)=ydata(ll,kk)
115          continue
c          endif
c          return
c      endif
c----- if pass a no matcha the b data then find new
c          a or b depending on whether or not ascending
c          or descending order of independent variable
c
c      if (abss .ge. 0.33) then
c          stocount=stocount+1
c----- if this is a dusk pass then will count from
c          -90.0 lat degrees toward the equator
c
c      if (dndk .eq. 0) then
c          if (xdata(jj,1) .gt. ydata(jj,1)) then
c              rowinc=rowinc-1
c              do 130 mm=1,rowinc
c                  do 130 kk=1,2
c                      ydata(mm,kk)=ydata(mm+1,kk)
130          continue
c          elseif (xdata(jj,1) .lt. ydata(jj,1)) then
c              rowli=rowli-1
c              do 150 nn=1,rowli
c                  do 150 kk=1,2
c                      xdata(nn,kk)=xdata(nn+1,kk)
150          continue
c          endif
c----- if this is a dawn pass then will count from
c          the equator toward the south pole
c          that is decreasing independent variable
c
c          elseif (dndk .eq. 1) then

```



```

c                                     the interpolator (not to confused with the
c                                     terminator!)
c
c      do 100 i=1,27
c          diffdata(i)=data(inum,i)-data(inum+1,i)
c      100 continue
c      do 120 i=1,27
c          xdata(i)=data(inum,i)+(xlat-data(inum,1))*
c          > (diffdata(i)/diffdata(1))
c      120 continue
c
c      return
c      end
c
c
c      subroutine despike (npts,outnum)
c      real data(400,27),desdata(400,27),upper,lower
c      integer ic(400),outnum,var,idata(400,2)
c      common data(400,27),idata(400,2)
c      common /spike/ desdata(400,27),upper,lower,var
c
c----- this subroutine also provided by Tiku
c
c      PROGRAM DESPIKE
c*****
c      PROGRAM DESPIKE REMOVES MOST SPIKES FROM THE INPUT DATA SET.
c      HOWEVER, FOR BEST RESULTS, IT IS SUGGESTED TO RUN DESPIKE
c      AT LEAST THREE TIMES --- FOR EXAMPLE:
c
c          INPUT1 ---DESPIKE---> OUTPUT1
c      (OUTPUT1 = INPUT2) ---DESPIKE---> OUTPUT2
c      (OUTPUT2 = INPUT3) ---DESPIKE---> OUTPUT3.
c
c      STILL, AFTER RUNNING DESPIKE THREE TIMES, IT FAILS TO ELIMINATE
c      ORBITS WITH DISCONTINUOUS RESID VS LATITUDE PROFILES.
c      PROGRAM DEGAP ATTEMPTS TO TAKE CARE OF SUCH PASSES.
c
c      PARAMETERS TO CHECK: "UPPER" AND "LOWER" (IN NANOTESLAS):
c
c      IF PROGRAM DESPIKE HAS DETERMINED OBSERVATION N TO BE
c      A GOOD POINT, IT THEN SETS OUT TO DETERMINE IF POINT N+1
c      IS A GOOD POINT. IT DOES THIS BY CHECKING THE POINTS
c      N, N+1, AND N+2. OBSERVATION N+1 WILL BE A GOOD POINT
c      IF THE RESIDUAL DIFFERENCE BETWEEN POINT N+1 AND THE
c      POINT ABOVE IT (N OR N+2) IS LESS THAN "UPPER" AND
c      IF THE RESIDUAL DIFFERENCE BETWEEN IT AND THE POINT
c      BELOW IT (N+2 OR N) IS GREATER THAN "LOWER".
c*****
c
c      DO 2 I=1,400
c          IC(I)=1
c      2 CONTINUE
c
c*****
c      ARE THE FIRST NEW POINTS SPIKES?
c      NOTE: DATA(U,23) = RESID2(U)
c
c      I=1
c      15 SL1=(DATA(I+1,var)-DATA(I,var))
c          SL2=(DATA(I+2,var)-DATA(I,var))
c          SL3=(DATA(I+3,var)-DATA(I,var))
c          SL4=(DATA(I+4,var)-DATA(I,var))
c          XSL=ABS(SL1+SL2+SL3+SL4)/4.0
c
c      S2=(DATA(I+2,var)-DATA(I+1,var))
c
c      IF (ABS(SL1).GT.(3.0*XSL).OR.ABS(SL1).GT.(ABS(3.0*S2))) IC(I)=0
c      IF (IC(I).EQ.0) THEN
c          I=I+1
c          GO TO 15
c      ENDIF
c
c*****
c      ARE THE MID POINTS SPIKES?
c
c      DO 20 J=I,NPTS-2
c          SL2=(DATA(J+1,var)-DATA(J+2,var))
c          IF (SL1.GT.UPPER.AND.SL2.LT.LOWER) IC(J+1)=0
c          IF (SL1.LT.LOWER.AND.SL2.GT.UPPER) IC(J+1)=0
c          SL1=SL2
c      20 CONTINUE
c
c*****
c      IS THE LAST POINT A SPIKE?
c
c      K=NPTS-2
c      25 IF (IC(K).EQ.0) THEN
c          K=K-1

```

```

        GO TO 25
    ENDIF
C
    SL1=ABS(DATA(K,var)-DATA(NPTS-1,var))
    SL2=ABS(DATA(NPTS-1,var)-DATA(NPTS,var))
    SL3=ABS(DATA(K,var)-DATA(NPTS,var))
    IF (IC(NPTS-1).EQ.0) THEN
        IF (SL1.GT.(3.0*SL2)) IC(NPTS)=0
        IF (SL3.GT.(3.0*UPPER)) IC(NPTS)=0
    ENDIF
    IF (IC(NPTS-1).EQ.1) THEN
        IF (SL2.GT.(3.0*SL1)) IC(NPTS)=0
    ENDIF
C
    NOBS=0
    DO 30 I=1,NPTS
    C
    C      IF (IC(I).EQ.1) NOBS=NOBS+1
    C 30 CONTINUE
    C      WRITE(6,*) IDATA(1,1), NOBS
    C
    outnum=0
    DO 35 I=1,NPTS
    C
    C      IF (IC(I).EQ.1) THEN
    C          outnum=outnum+1
    C          do 32 m=1,27
    C              desdata(outnum,m)=data(i,m)
    C              continue
    C 32
    C          ENDIF
    C 35 CONTINUE
    C
    return
END

```



```

program message
character*80 filename
character*10 dndk
real data(400,27),intpdata(400,27),movdata(400,27),
> dstore(27),desdata(400,27),upper,lower,mean,
> varmax,mincc,strtndat(400)
integer idata(400,2),countall,innum,outnum,winlen2,incwen2,
> istore(2),denum,cnter,spknum,spkvar,movvar,choice,
> vary,nowant(4000),col,eight,zero,gfchoice,
> col3,mincheck,gftype,passrem,recnum,gfcnt,winlen1,
> winlen2a,winlen2b
common data(400,27)
common /intb/ intpdata(400,27)
common /move/ movdata(400,27),winlen2,incwen2,movvar,gftype,
> varmax,mincc,incwen1,winlen1,winlen2a,winlen2b
common /spike/ desdata(400,27),upper,lower,spkvar
common /trax/ x(400),y(400)

c
c----- program description
c
c      ok, first the name of the program.  to be frank, i just couldn't
c      think of shortened name for despke-moving-average-min-max-
c      cubic-spline-linear-interpolation... so i just called the
c      program "message" because this program massages the data a bit!!
c      this program takes data in the 2-integers and 27-reals format
c      and after a bit of work writes the worked over data in either
c      2i-27r or the more usual format of a file of latitudes, longitudes
c      and radii separated by headers and a file of residuals separated
c      by headers.  the bit of work includes, 1) removing bad data points
c      characterized by a large change in magnitude from surrounding
c      data points. ie: removing "spikes".  2) fitting a moving average
c      to the despiked dataset.  3) interpolating every 0.33 degrees of
c      latitude on the moving average (guide function).  4) interpolating
c      the despiked dataset.  interpolating schemes are linear for
c      the initial run through on a pass, then the gf is a spline.
c      5) fit and remove a least squares core field from the data.
c      of course there are several variations on the above scheme which
c      can be figured out be reading the write (*,*) statements.
c      NOTE: if certain passes are NOT wanted, this program will
c      remove them from the processing.
c      NOTE: i've found that the bandpass filter works better than
c      removing a guide function or cubic spline, but u can
c      do as u like.
c      NOTE: for optimal results, make use of the least squares
c      core field removal as applied by message.
c      NOTE: for ibm rs6000, recl=116.  for dec3100, recl=29
c
c      program date: 16 apr 91
c
c      write (*,*) 'INPUT 2I-27R FILE'
c      read (*,9990) filename
c      9990 format (a80)
c      open (10, file=filename,status='old',form='unformatted',
c      > access='direct',recl=116)
c
c      write (*,*) 'TYPE dawn OR dusk AS APPROPRIATE'
c      read (*,9991) dndk
c      9991 format (a10)
c
c      write (*,*) '0 IF YOU WANT ALL PASSES'
c      write (*,*) '1 IF CERTAIN PASSES NEED TO BE REMOVED'
c      read (*,*) choice
c      if (choice .eq. 1) then
c        write (*,*) 'INPUT FILE OF PASSES YOU DO NOT WANT'
c        read (*,9990) filename
c        open (11, file=filename,status='old',form='formatted')
c      endif
c
c      write (*,*) '0 FOR CUBIC SPLINE AND DATA OUTPUT'
c      write (*,*) '1 FOR ONLY CUBIC SPLINE OUTPUT'
c      write (*,*) '2 FOR ONLY DATA OUTPUT (the usual choice)'
c      read (*,*) gfchoice
c      write (*,*) 'WHICH 27R VARIABLE TO BE WRITTEN TO FILE(S) (12)'
c      write (*,*) '1=LAT, 2=LONG ,..12=bva,...23=totavgmag'
c      write (*,*) 'lat lon rad mlt invlat diplat bs bv x y z'
c      write (*,*) 'bva xa ya za totfld xfld yfld zfld inc dec'
c      write (*,*) 'totmag totavgmag resid resavgmag ringcur sec'
c      write (*,*) '0 IF YOU WANT 2I-27R OUTPUT'
c      read (*,*) vary
c      write (*,*) '1 FIT LEAST SQUARES CORE FIELD TO THIS VARIABLE'
c      write (*,*) '0 DO NOT FIT CORE FIELD'
c      write (*,*) 'choose 1'
c      read (*,*) ixfit
c      if (ixfit .eq. 1) then
c        write (*,*) 'OUTPUT FILE FOR PASS NUMBERS AND X VALUES'
c        read (*,9990) filename
c        open (22, file=filename, form='formatted')
c      endif
c
c      if (gfchoice .eq. 0 .or. gfchoice .eq. 2) then

```

```

        if (vary .eq. 0) then
            write (*,*) 'OUTPUT 2I-27R DATA FILE'
            read (*,9990) filename
            open (20, file=filename,form='unformatted')
        endif
        if (vary .gt. 0) then
            write (*,*) 'OUTPUT DATA FILE OF HEADERS AND VARIABLE'
            read (*,9990) filename
            open (20, file=filename,form='unformatted')
            write (*,*) 'OUTPUT DATA FILE OF HEADERS'
            write (*,*) 'AND INTERP-LATS, LONGS, RADII'
            read (*,9990) filename
            open (21, file=filename,form='unformatted')
        endif
    endif
c
20 continue
    write (*,*) '0 FOR NO DESPIKING OF DATA SET'
    write (*,*) '1 FOR DESPIKING ONCE'
    write (*,*) '2 FOR DESPIKING TWICE (this is the usual choice)'
    write (*,*) '3 ... AND SO ON'
    read (*,*) spknum
    if (spknum .gt. 0) then
        write (*,*) 'WHAT IS THE MAXIMUM nT: (1.0)'
        write (*,*) 'WHAT IS THE MINIMUM nT: (-1.0)'
        read (*,*) upper, lower
        write (*,*) 'WHICH VARIABLE TO DESPIKE: (23)'
        write (*,*) '1-LAT, 2=LONG,...12=bva,...23=totavgmag'
        write (*,*) 'lat lon rad mlt invlat diplat bs bv x y z'
        write (*,*) 'bva xa ya za totfld xfld yfld zfld inc dec'
        write (*,*) 'totmag totavgmag resid resavgmag ringcur sec'
        read (*,*) spkvar
    endif
c
    if (gfcchoice .lt. 2) then
        write (*,*) 'WHICH VARIABLE TO WORK WITH IN CUBIC SPLINE: (12)'
        write (*,*) '1-LAT, 2=LONG,...12=bva,...23=totavgmag'
        write (*,*) 'lat lon rad mlt invlat diplat bs bv x y z'
        write (*,*) 'bva xa ya za totfld xfld yfld zfld inc dec'
        write (*,*) 'totmag totavgmag resid resavgmag ringcur sec'
        read (*,*) movvar
        if (vary .eq. 0) then
            write (*,*) 'OUTPUT 2I-27R CUBIC SPLINE FILE'
            read (*,9990) filename
            open (23, file=filename,form='unformatted')
        endif
        if (vary .gt. 0) then
            write (*,*) 'OUTPUT FILE OF CUBIC SPLINE VARIABLE'
            read (*,9990) filename
            open (23, file=filename,form='unformatted')
            write (*,*) 'OUTPUT FILE OF CUBIC SPLINE HEADERS AND'
            write (*,*) 'AND INTERP-LATS, LONGS, RADII'
            read (*,9990) filename
            open (24, file=filename,form='unformatted')
            write (*,*) 'OUTPUT FILE OF DATA - CUBIC SPLINE'
            read (*,9990) filename
            open (28, file=filename,form='unformatted')
        endif
        write (*,*) 'OUTPUT STATISTICS FILE'
        read (*,9990) filename
        open (25, file=filename,form='formatted')
        write (25,*) 'PASS      VAR      STDEV      MIN      MEAN      MAX'
        write (*,*) 'OUTPUT FILE OF TRACKS FITTED WITH A CUBIC SPLINE'
        read (*,9990) filename
        open (26, file=filename,form='unformatted')
        write (*,*) 'OUTPUT FILE OF TRACKS NOT FITTED'
        read (*,9990) filename
        open (27, file=filename,form='unformatted')
        write (*,*) 'TYPE OF CUBIC SPLINE TO APPLY TO DATA: (2)'
        write (*,*) '1 FOR A MOVING AVERAGE'
        write (*,*) '2 FOR A MIN-MAX-AVERAGE FINDER'
        read (*,*) gftype
        if (gftype .eq. 1) then
            incwn2=0
            winlen2=0
            winlen2a=0
            winlen2b=0
            write (*,*) 'WHAT IS THE LENGTH OF THE WINDOW:'
            read (*,*) winlen1
            write (*,*) 'HOW MANY POINTS TO INCREMENT WINDOW LOCATION:'
            write (*,*) 'should be equal to or greater than 1'
            read (*,*) incwn1
        elseif (gftype .eq. 2) then
            write (*,*) 'LENGTH OF THE first AVERAGING WINDOW:'
            read (*,*) winlen2a
            write (*,*) 'LENGTH OF THE min-max AVERAGING WINDOW:'
            read (*,*) winlen2
            write (*,*) 'LENGTH OF THE last AVERAGING WINDOW:'
            read (*,*) winlen2b
            write (*,*) 'HOW MANY POINTS TO SEARCH FROM AN ENDPOINT TO FIND'

```



```

write (*,*) 'IF THE MIN OR MAX POINT SHOULD BE REMOVED'
read (*,*) incwcn2
write (*,*) 'IF MINCC CAN NOT BE MATCHED THEN'
write (*,*) 'WHAT IS THE LENGTH OF THE AVERAGING WINDOW'
read (*,*) winlen1
write (*,*) 'IF MINCC CAN NOT BE MATCHED THEN'
write (*,*) 'HOW MANY POINTS TO INCREMENT WINDOW LOCATION:'
write (*,*) 'should be equal to or greater than 1'
read (*,*) incwcn1
endif
write (*,*) 'MAXIMUM VARIANCE WITHOUT FITTING A CUBIC SPLINE'
read (*,*) varmax
write (*,*) 'MINIMUM CORRELATION COEFFICIENT OF CUBIC SPLINE TO'
write (*,*) 'ORIGINAL DATA'
read (*,*) mincc
endif
write (*,*) 'AND FINALLY - WHAT IS THE MINIMUM NUMBER OF'
write (*,*) 'OBSERVATIONS ALLOWABLE FOR EACH PASS (50)'
read (*,*) mincheck
c
  if (choice .eq. 1) then
    do 50 kk=1,4000
      read (11,*,end=55) nowant(kk)
50    continue
55    continue
      choice=kk-1
    endif
c
c----- read the data and find all lines
c      for each individual pass
      noc=0
      nocgf=0
      qfent=0
      ltercnt=0
      passrem=0
      countall=0
      jstop=0
      ifirstcnt=0
      lsecnt=0
      lendcnt=0
      l3cnt=0
      l4cnt=0
      l5cnt=0
      l6cnt=0
      l7cnt=0
      l8cnt=0
      lbigcnt=0
      lswitch=0
      llowcnt=0
      recnum=1
      read (10,rec=recnum) (idata(1,i),i=1,2), (data(1,j),j=1,27)
100    n=2
105    recnum=recnum+1
      read (10,rec=recnum,err=110) (idata(n,i),i=1,2), (data(n,j),j=1,27)
      if (idata(n,1) .ne. idata(n-1,1)) go to 120
      n=n+1
      go to 105
110    continue
      jstop=1
120    continue
      do 130 i=1,2
        istore(i)=idata(n,i)
130    continue
      do 140 i=1,27
        dstore(i)=data(n,i)
140    continue
c
      countall=countall+1
c----- if passes are NOT wanted, remove them
      if (choice .eq. 0) go to 145
      do 63 ii=1,choice
        if (idata(1,ii) .eq. nowant(ii)) then
c          write (*,*) 'PASS NUMBER REMOVED ',nowant(ii),idata(1,ii)
          passrem=passrem+1
          go to 400
        endif
63    continue
145    continue
c
      innum=n-1
c
      if (innum .lt. mincheck) then
        write (*,9980) idata(1,1),innum
9980      format ('PASS REMOVED AT READ =',i6,' OBSERV COUNT =',i5)
        passrem=passrem+1
        go to 400
      endif
c----- search for passes that cross the
c      -180.0 180.0 meridian

```

```

      call meridian (innum)
c
c----- despike the data if user chooses and
c----- despike the number of times chosen
      if (spknum .eq. 0) go to 190
      cnter=0
150  call despike (innum,denum)
      cnter=cnter+1
      innum=denum
      do 180 k=1,innum
        do 180 kk=1,27
          data(k, kk)=desdata(k, kk)
        continue
      180  if (cnter .lt. spknum) go to 150
c
190  continue
      if (innum .lt. mincheck) then
        write (*,9981) idata(1,1),innum
9981  format ('PASS REMOVED AFTER DESPIKING =',16,
>          ' OBSERV COUNT =',15)
        passrem=passrem+1
        go to 400
      endif
c
c----- interpolate the dataset
      call interp1 (dndk,innum,outnum)
      innum=outnum
      if (innum .lt. mincheck) then
        write (*,9982) idata(1,1),innum
9982  format ('PASS REMOVED AFTER INTERPOLATING =',16,
>          ' OBSERV COUNT =',15)
        passrem=passrem+1
        go to 400
      endif
c
      do 205 i=1,innum
        x(i)=intpdata(i,1)
        y(i)=intpdata(i,2)
      205  continue
c
c----- fit the core field (#16) profile to
c----- the chosen variable profile
      if (ixfit .eq. 1) then
        call sqrfit (innum,xxx,vary)
        write (22,*) idata(1,1),xxx
      endif
c
      if (gfchoice .eq. 1) go to 300
      if (vary .eq. 0) go to 230
      col=1
      col3=3
      zero=0
      mean=0.0
      eight=8888
      write (20) outnum,col,zero,mean,idata(1,1),eight
      write (21) outnum,col3,zero,mean,idata(1,1),eight

      do 210 m=1,outnum
        if (intpdata(m,2).gt.180.0) intpdata(m,2)=intpdata(m,2)-360.0
        write (20) intpdata(m,vary)
        write (21) intpdata(m,1),intpdata(m,2),intpdata(m,3)
        strintdat(m)=intpdata(m,vary)
      210  continue
      230  if (vary .gt. 0) go to 300
          do 250 i=1,outnum
            if (intpdata(i,2).gt.180.0) intpdata(i,2)=intpdata(i,2)-360.0
            write (20) (idata(1,j),j=1,2),(intpdata(1,j),j=1,27)
          250  continue
c
c----- this if statement if chosen, will fit
c----- the cubic spline, interpolate it and
c----- write it to file
      300  continue
          if (gfchoice .lt. 2) then
            do 310 k=1,innum
              do 310 kk=1,27
                data(k, kk)=intpdata(k, kk)
              continue
            310
c
          >  call moving (innum,num,idata(1,1),eight,gfcent,dndk,itercnt,
          >          ifirstcnt,iseccnt,iendcnt,i3cnt,i4cnt,i5cnt,
          >          i6cnt,i7cnt,i8cnt,ibigcnt,iswitch,ilowcnt)
          outnum=innum
c
          if (eight .eq. 7777) call track (27,innum,noc,nocgf)
c
          if (vary .gt. 0) then
            col=1
            col3=3
            zero=0
            mean=0.0

```

```

      if (eight .eq. 8888) then
        write (28) outnum,col,zero,mean,idata(1,1),eight
        write (23) outnum,col,zero,mean,idata(1,1),eight
        write (24) outnum,col3,zero,mean,idata(1,1),eight

        do m=1,outnum
          write (28) (strintdat(m)-intpdata(m,vary))
        enddo
      elseif (eight .eq. 7777) then
        ieight=8888
        write (28) outnum,col,zero,mean,idata(1,1),ieight
        write (23) zero,col,zero,mean,idata(1,1),eight
        write (24) zero,col3,zero,mean,idata(1,1),eight
        do m=1,outnum
          write (28) strintdat(m)
        enddo
        go to 400
      endif

c      call track (26,outnum,noc,nocgf)
c
      do 350 m=1,outnum
        if (intpdata(i,2).gt.180.0)
          intpdata(i,2)=intpdata(i,2)-360.0
        write (23) intpdata(m,vary)
        write (24) intpdata(m,1),intpdata(m,2),intpdata(m,3)
350      continue
      endif
      if (vary .eq. 0) then
        if (eight .eq. 7777) then
          write (23) eight
          go to 400
        endif
c      call track (26,outnum,noc,nocgf)
c
      do 370 m=1,outnum
        if (intpdata(i,2).gt.180.0)
          intpdata(i,2)=intpdata(i,2)-360.0
        write (23) (idata(1,mm),mm=1,2),
          (intpdata(m,mm),mm=1,27)
370      continue
      endif
      endif

c----- set idata(1,i) and data(1,i) to the
c          previously read values and go back and
c          get the rest of the values for the pass
400      continue
      do 410 i=1,2
        idata(1,i)=istore(i)
      continue
410      do 420 i=1,27
        data(1,i)=dstore(i)
      continue
420      if (jstop .eq. 1) go to 999
      go to 100

c
999      continue
      write (*,*) 'records read =',recnum-1
      write (*,*) 'passes read =',countall
      write (*,*) 'passes removed =',passrem
      write (*,*) 'passes fitted with a cubic spline =',gfcnt
      write (*,*) 'passes without a cubic spline =',
        > countall-gfcnt-passrem
      write (*,*) 'total extra iterations =',itercnt-gfcnt
      if (gftype .eq. 2) then
        write (*,*) ifirstcnt, ' first points were removed'
        write (*,*) isecnt, ' second points were removed'
        write (*,*) iswitch, ' orbits used a moving-average gf'
      endif
      write (*,*) iendcnt, ' passes were 2nd order'
      write (*,*) i3cnt, ' passes were 3rd order'
      write (*,*) i4cnt, ' passes were 4th order'
      write (*,*) i5cnt, ' passes were 5th order'
      write (*,*) i6cnt, ' passes were 6th order'
      write (*,*) i7cnt, ' passes were 7th order'
      write (*,*) i8cnt, ' passes were 8th order'
      write (*,*) ibigcnt, ' passes were larger than 8th order'
      write (*,*) ilowcnt, ' passes were below cc of',mincc
      close (10)
      close (11)
      close (20)
      close (21)
      close (23)
      close (24)
      close (25)
      close (26)
      close (27)
      stop

```

```

      end
c
c
c
      subroutine meridian (innum)
      real data(400,27)
      integer innum
      common data(400,27)
c----- subroutine description
c      this subroutine determines if a pass crosses the -180.0 180.0
c      meridian. if a pass does cross, then 360.0 is added to the
c      negative values so that the interpolation scheme does not
c      try to interpolate from -180.0 to 180.0 every 0.33 degrees
c
      do 100 i=1,innum-1
        if (data(i,2) .lt. data(i+1,2)) then
          do 150 ii=1,innum
            if (data(ii,2) .lt. 0.0) data(ii,2)=data(ii,2)+360.0
150          continue
          go to 200
        endif
100      continue
c
200      continue
      return
      end
c
c
c
c
      subroutine interp1 (dndk,num,ii)
      real data(400,27),xdata(27),intpdata(400,27)
      integer num
      character*10 dndk
      common data(400,27)
      common /inta/ xdata(27)
      common /intb/ intpdata(400,27)
c----- subroutine description
c
c      the basic concept of this subroutine was provided by:
c      Dr. D.N. "Tiku" Ravat
c      Dept. of Geology
c      Purdue University
c      this subroutine linearly interpolates ALL 27-r variables by
c      basing the interpolation on the latitudes which are interpolated
c      at every 0.33 degrees of starting latitude.
c
      ii=0
      xlat=real(int(data(1,1)*100.0))/100.0
      if (dndk .eq. 'dusk') then
        if (xlat .lt. data(1,1)) xlat=xlat + 0.33
        i=1
100      if (xlat.ge.data(1,1) .and. xlat.le.data(i+1,1)) then
        call interp2 (i,xlat)
        xdata(2)=real(int(xdata(2)*100.0))/100.0
        ii=ii+1
        do 150 j=1,27
          intpdata(ii,j)=xdata(j)
150        continue
        xlat=xlat + 0.33
        if (xlat.gt. data(num,1)) return
        go to 100
        elseif (xlat.gt. data(i+1,1)) then
          i=i+1
          go to 100
        endif
c
      elseif (dndk .eq. 'dawn') then
        if (xlat.gt. data(1,1)) xlat=xlat - 0.33
        i=1
180      if (xlat.le.data(1,1) .and. xlat.ge.data(i+1,1)) then
        call interp2 (i,xlat)
        xdata(2)=real(int(xdata(2)*100.0))/100.0
        ii=ii+1
        do 200 j=1,27
          intpdata(ii,j)=xdata(j)
200        continue
        xlat=xlat - 0.33
        if (xlat.lt. data(num,1)) return
        go to 180
        elseif (xlat.lt. data(i+1,1)) then
          i=i+1
          go to 180
        endif
      endif
c
      end
c
c
c

```

```

c      subroutine interp2 (inum,xlat)
c      real data(400,27),diffdata(27),xdata(27)
c      integer inum
c      common data(400,27)
c      common /inta/ xdata(27)
c
c----- this subroutine is also from Tiku and is
c      the interpolator (not to confused with the
c      terminator!)
c
c      do 100 i=1,27
c          diffdata(i)=data(inum,i)-data(inum+1,i)
c          continue
c      do 120 i=1,27
c          xdata(i)=data(inum,i)+(xlat-data(inum,i))*
c              (diffdata(i)/diffdata(1))
c      120 continue
c
c      return
c      end
c
c
c      SUBROUTINE SPLINE(X,Y,N,YP1,YPN,Y2)
c      PARAMETER (NMAX=100)
c      DIMENSION X(N),Y(N),Y2(N),U(NMAX)
c
c----- subroutine description
c      this subroutine provided by the authors of Numerical Recipes
c      Numerical Recipes (fortran)
c      The Art of Scientific Computing
c      Cambridge University Press, 1989
c      Copyright (C) 1986, 1992 Numerical Recipes Software
c      IF (YP1.GT..99E30) THEN
c          Y2(1)=0.
c          U(1)=0.
c      ELSE
c          Y2(1)=-0.5
c          U(1)=(3./(X(2)-X(1)))*((Y(2)-Y(1))/(X(2)-X(1))-YP1)
c      ENDIF
c      DO 11 I=2,N-1
c          SIG=(X(I)-X(I-1))/(X(I+1)-X(I-1))
c          P=SIG*Y2(I-1)+2.
c          Y2(I)=(SIG-1.)/P
c          U(I)=(6.*((Y(I+1)-Y(I))/(X(I+1)-X(I))-(Y(I)-Y(I-1))
c              / (X(I)-X(I-1)))/(X(I+1)-X(I-1))-SIG*U(I-1))/P
c      11 CONTINUE
c      IF (YPN.GT..99E30) THEN
c          QN=0.
c          UN=0.
c      ELSE
c          QN=0.5
c          UN=(3./(X(N)-X(N-1)))*(YPN-(Y(N)-Y(N-1))/(X(N)-X(N-1)))
c      ENDIF
c      Y2(N)=(UN-QN*U(N-1))/(QN*Y2(N-1)+1.)
c      DO 12 K=N-1,1,-1
c          Y2(K)=Y2(K)*Y2(K+1)+U(K)
c      12 CONTINUE
c      RETURN
c      END
c
c
c      SUBROUTINE SPLINT(XA,YA,Y2A,N,X,Y)
c      DIMENSION XA(N),YA(N),Y2A(N)
c
c----- subroutine description
c      Copyright (C) 1986, 1992 Numerical Recipes Software
c      KLO=1
c      KHI=N
c      1 IF (KHI-KLO.GT.1) THEN
c          K=(KHI+KLO)/2
c          IF (XA(K).GT.X) THEN
c              KHI=K
c          ELSE
c              KLO=K
c          ENDIF
c      GOTO 1
c      ENDIF
c      H=XA(KHI)-XA(KLO)
c      IF (H.EQ.0.) PAUSE 'Bad XA input.'
c      A=(XA(KHI)-X)/H
c      B=(X-XA(KLO))/H
c      Y=A*YA(KLO)+B*YA(KHI)+
c      * ((A**3-A)*Y2A(KLO)+(B**3-B)*Y2A(KHI))*(H**2)/6.
c      RETURN
c      END
c
c
c      subroutine moving (nobs,inum,passnum,eight,qfent,dndk,

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```

>          itercnt,ifirstcnt,iseccnt,iendcnt,
>          i3cnt,i4cnt,i5cnt,i6cnt,i7cnt,i8cnt,
>          ibigcnt,switch,ilowcnt)
integer winlen,incwen,nobs,minm,
>          wwinlen2,iincwen2,iincwen1,var,maxm,
>          gftype,passnum,eight,gfcnt,subwinlen,strnobs,
>          ggftype,wwinlen1,wwinlen2a,wwinlen2b
real data(400,27),movdata(400,27),minval,maxval,
>          varmax,strdata(400,27),intpdata(400,27),mincc,
>          x(100),y(100),y2(100),
>          sdata(400,27)
character*10 dndk
common data(400,27)
common /move/ movdata(400,27),wwinlen2,iincwen2,var,ggftype,
>          varmax,mincc,iincwen1,wwinlen1,wwinlen2a,
>          wwinlen2b
common /intb/ intpdata(400,27)

c
c----- subroutine description
c
c      subroutine moving creates the cubic spline fit of each pass with
c      a variance above the user defined limit. this cubic spline will
c      match the original pass to within the user defined correlation
c      coefficient. the cubic spline is the time domain representation
c      of the non-lithospheric components in the pass. the following
c      source was used as a reference for the statistical calculations:
c
c          Davis, Statistics and Data Analysis in
c          Geology, 2nd ed., 1986 pp. 41
c----- loops that sum x, x**2
c
      strnobs=nobs
      xsum=0.0
      xsumsq=0.0
      xmin=data(1,var)
      xmax=xmin
      do 10 j=1,nobs
          xsum=xsum+data(j,var)
          xsumsq=xsumsq+(data(j,var))**2
          xmin=min(xmin,data(j,var))
          xmax=max(xmax,data(j,var))
10      continue
      nobss=float(nobs)
c----- find corrected sum of squares and mean
c
      xcsumsq=xsumsq-((xsum**2)/nobss)
      xmean=xsum/nobss
c----- find variance, standard deviation
c
      xvar=xcsumsq/(nobss-1.0)
      xstdev=sqrt(xvar)
c----- write out this mess for individual pass
c
      write (25,9992) passnum,xvar,xstdev,xmin,xmean,xmax
      9992 format (i6,5f14.5)
c----- if the variance of the pass is below the user
c      defined limit then race on back to main program
c
      if (xvar .le. varmax) then
          eight=7777
          return
      endif
      gftype=ggftype
      gfcnt=gfcnt+1
      do 15 i=1,nobs
          do 15 j=1,27
              strdata(i,j)=data(i,j)
15      continue
      subwinlen=0
c----- use a moving average fit
17      if (gftype .eq. 1) then
          itercnt=itercnt+1
          winlen=wwinlen1
          incwen=iincwen1
          inum=1
          if (subwinlen .gt. 0) then
              if (incwen .gt. 1) then
                  incwen=incwen-subwinlen
                  go to 25
              elseif (incwen .lt. winlen) then
                  winlen=winlen-subwinlen
                  if (winlen .lt. 2) stop 1110
              endif
          endif
          continue
25      endif
          xdivide=real(nobs)/real(incwen+winlen-1)
          xp5=(real(int(xdivide)))+0.5
          if (xdivide .lt. xp5) iddivide=int(xdivide)
          if (xdivide .ge. xp5) iddivide=int(xdivide)+1

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```

        xwinlen=real(nobs)/real(idivide)
        iwinadd=int((xwinlen-(real(int(xwinlen))))*real(idivide))
        winlen=int(xwinlen)-incwen
        istrwinlen=winlen
        iadd=0
        if (iwinadd.gt. 0 .and. iadd.lt. iwinadd) then
            iadd=iadd+1
            winlen=winlen+1
        endif
        i1=(winlen-1)/2
        i3=i1
        i7=0
        if (i1.gt. nobs) then
            i1=nobs/2
            i7=1
        endif
        avgdat=0.0
        do j=1,i1
            avgdat=data(j,var)+avgdat
        enddo
        do 20 j=1,27
            movdata(inum,j)=data(1,j)
20      continue
        movdata(inum,var)=avgdat/(real(i1))
        if (i7.eq. 1) go to 100
        continue
30      winlen=istrwinlen
        if (iwinadd.gt. 0 .and. iadd.lt. iwinadd) then
            iadd=iadd+1
            winlen=winlen+1
        endif
        i2=i3+incwen
        i3=i2+winlen-1
        i4=i2+((i3-i2)/2)
        if (i3.gt. nobs-i1+1) go to 100
        avgdat=0.0
        inum=inum+1
        do 50 j=i2,i3
            avgdat=avgdat+data(j,var)
50      continue
        do 70 j=1,27
            movdata(inum,j)=data(i4,j)
70      continue
        movdata(inum,var)=avgdat/(i3-i2+1)

        go to 30
100     continue

        inum=inum+1
        avgdat=0.0
        do j=(nobs-i1+1),nobs
            avgdat=avgdat+data(j,var)
        enddo
150     do 170 j=1,27
            movdata(inum,j)=data(nobs,j)
170     continue
        movdata(inum,var)=avgdat/(real(i1))
c----- or use the minimum and maximum values
c                                         within the window length
c
        elseif (gftype.eq. 2) then
            itercnt=itercnt+1
            winlen=wwinlen2
            incwen=iincwen2
            winlena=wwinlen2a
            winlenb=wwinlen2b
            if (winlena.gt.nobs.or. winlenb.gt.nobs.or.
>         incwen.gt.nobs.or. (winlena+1).ge.(nobs-winlenb)) then
                do i=1,27
                    movdata(1,i)=data(1,i)
                    movdata(2,i)=data(nobs,i)
                enddo
                avgdat=0.0
                do i=1,nobs/2
                    avgdat=data(i,var)+avgdat
                enddo
                avgdat=avgdat/real(nobs/2)
                movdata(1,var)=avgdat
                avgdat=0.0
                do i=(nobs/2)+1,nobs
                    avgdat=data(i,var)+avgdat
                enddo
                avgdat=avgdat/real(nobs-(nobs/2))
                movdata(2,var)=avgdat
                iendcnt=iendcnt+1
                inum=2
                go to 700

```

```

endif
avgdat=0.0
do 500 i=1,winlena
500   avgdat=data(i,var)+avgdat
      avgdat=avgdat/real(winlena)
      do 510 i=1,27
510       movdata(1,i)=data(1,i)
          movdata(1,var)=avgdat
          i1=winlena+1
          i2=nobs-winlenb
          i3=0
          i4=nobs-winlenb+1
          i5=nobs
          i6=nobs
          maxval=-1.0e10
          minval=1.0e10
          do 520 m=i1,i2
              minval=min(minval,data(m,var))
              if (minval .eq. data(m,var)) minm=m
              maxval=max(maxval,data(m,var))
              if (maxval .eq. data(m,var)) maxm=m
520          continue
              ilow=minm-((winlen-1)/2)
              ihi=minm+((winlen-1)/2)
              if (ilow .lt. 1) ilow=1
              if (ihi .gt. nobs) ihi=nobs
              avgdatmin=0.0
              do 530 i=ilow,ihi
                  avgdatmin=avgdatmin+data(i,var)
530              avgdatmin=avgdatmin/real(ihi-ilow+1)
                  ilow=maxm-((winlen-1)/2)
                  ihi=maxm+((winlen-1)/2)
                  if (ilow .lt. 1) ilow=1
                  if (ihi .gt. nobs) ihi=nobs
                  avgdatmax=0.0
                  do 540 i=ilow,ihi
                      avgdatmax=avgdatmax+data(i,var)
540                  avgdatmax=avgdatmax/real(ihi-ilow+1)
                      if (minm .lt. maxm) then
                          do 570 j=1,27
                              movdata(2+i3,j)=data(minm,j)
                              movdata(3+i3,j)=data(maxm,j)
                              movdata(2+i3,var)=avgdatmin
                              movdata(3+i3,var)=avgdatmax
570                          continue
                              elseif (minm .gt. maxm) then
                                  do 590 j=1,27
                                      movdata(2+i3,j)=data(maxm,j)
                                      movdata(3+i3,j)=data(minm,j)
                                      movdata(2+i3,var)=avgdatmax
                                      movdata(3+i3,var)=avgdatmin
590                                  continue
                                  endif
                                  avgdat=0.0
                                  do 594 i=14,15
594                                      avgdat=data(i,var)+avgdat
                                          avgdat=avgdat/real(i5-i4+1)
                                          do 596 i=1,27
596                                              movdata(4+i3,i)=data(i6,i)
                                                  movdata(4+i3,var)=avgdat
                                                  inum=inum+1
                                                  if (dndk .eq. 'dusk') then
                                                      if (movdata(2+i3,1) .le.
> (movdata(1+i3,1)+(real(incwen)*0.33))) then
                                                          ifirstcnt=ifirstcnt+1
                                                          do 600 j=2,3
500                                                              do 600 i=1,27
>                                                                  movdata(j+i3,i)=movdata(j+1+i3,i)
600                                                                  inum=inum-1
>                                                                  endif
>                                                                  if (movdata(inum+1+i3,1) .ge.
> (movdata(inum+1+i3,1)-(real(incwen)*0.33))) then
>                                                          iseccnt=iseccnt+1
>                                                          do 610 i=1,27
610                                                              movdata(inum-1+i3,i)=movdata(inum+1+i3,i)
>                                                              inum=inum-1
>                                                              endif
>                                                              elseif (dndk .eq. 'dawn') then
>                                                                  if (movdata(2+i3,1) .ge.
> (movdata(1+i3,1)-(real(incwen)*0.33))) then
>                                                          ifirstcnt=ifirstcnt+1
>                                                          do 620 j=2,3
620                                                              do 620 i=1,27
>                                                                  movdata(j+i3,i)=movdata(j+1+i3,i)
>                                                                  inum=inum-1
>                                                                  endif
>                                                                  if (movdata(inum+1+i3,1) .le.
> (movdata(inum+1+i3,1)+(real(incwen)*0.33))) then
>                                                          iseccnt=iseccnt+1

```



```

        do 630 i=1,27
630          movdata(inum-1+i3,1)=movdata(inum+i3,1)
          inum=inum-1
        endif
      endif
    endif
c
700 continue
    if (dndk .eq. 'dusk') then
      do 401 i=1,inum
        x(i)=movdata(i,1)
        y(i)=movdata(i,var)
401      continue
    elseif (dndk .eq. 'dawn') then
      do 404 i=1,inum
        ii=inum-i+1
        x(i)=movdata(ii,1)
        y(i)=movdata(ii,var)
404      continue
    endif
    oneslope=(y(2)-y(1))/(x(2)-x(1))
    twoslope=(y(inum)-y(inum-1))/(x(inum)-x(inum-1))
    call spline (x,y,inum,oneslope,twoslope,y2)
    do 402 i=1,nobs
      ii=nobs-i+1
      xint=data(i,1)
      if (dndk .eq. 'dawn') xint=data(ii,1)
      call splint (x,y,y2,inum,xint,yint)
      do 403 j=1,27
        intpdata(i,j)=data(i,j)
        if (dndk .eq. 'dawn') intpdata(i,j)=data(ii,j)
403      continue
      intpdata(i,var)=yint
402 continue
    if (dndk .eq. 'dawn') then
      do 405 i=1,nobs
        ii=nobs-i+1
        do 405 j=1,27
          sdata(i,j)=intpdata(ii,j)
405      continue
      do 406 i=1,nobs
        do 406 j=1,27
          intpdata(i,j)=sdata(i,j)
406      continue
    endif
c
c----- calculate the correlation coefficient between
c          the original data and the cubic spline
c
c----- loops that sum x, x**2, y, y**2 and xy
    if (nobs .ne. strnobs) stop 0002
    nobss=real(nobs)
    xsum=0.0
    xsumsq=0.0
    ysum=0.0
    ysumsq=0.0
    sumxy=0.0
    do 440 j=1,nobs
      xsum=xsum+strdata(j,var)
      xsumsq=xsumsq+(strdata(j,var))**2
      ysum=ysum+intpdata(j,var)
      ysumsq=ysumsq+(intpdata(j,var))**2
      sumxy=sumxy+(strdata(j,var)*intpdata(j,var))
440 continue
c----- find corrected sum of products, covariance
c          and corrected sum of squares (x) (y)
c
    sumprod=sumxy-((xsum*ysum)/nobss)
    covarxy=sumprod/(nobss-1.0)
    xcsumsq=xsumsq-((xsum**2)/nobss)
    ycsumsq=ysumsq-((ysum**2)/nobss)
c
c----- find variance, standard deviation for x and y
c
    xvar=xcsumsq/(nobss-1.0)
    yvar=ycsumsq/(nobss-1.0)
    xstdev=sqrt(xvar)
    ystdev=sqrt(yvar)
c----- find correlation coefficient by Davis method
    corrDxy=covarxy/(xstdev*ystdev)
c
c----- if the fit between cubic spline and original data
c          is below the minimum acceptable user defined
c          correlation coefficient limit, then shorten the
c          windows by a length equivalent to subwinlen. then
c          rerun the entire subroutine from statement 17
c
    if (corrDxy .lt. mincc .and. gftype .eq. 2) then
      write (*,*) passnum, ' pass below cc limit',corrDxy
      gftype=1
    endif

```

```

        iswitch=iswitch+1
        do 450 i=1,nobs
            do 450 j=1,27
                data(i,j)=strdata(i,j)
450      continue
        go to 17
    endif
    if (corrDxy .lt. mincc .and. gftype .eq. 1) then
        if (i7 .eq. 1) then
            write (*,*) passnum, ' pass below cc limit', corrDxy
            ilowcnt=ilowcnt+1
            go to 999
        endif
        subwinlen=subwinlen+1
        do 460 i=1,nobs
            do 460 j=1,27
                data(i,j)=strdata(i,j)
460      continue
        go to 17
    endif
c
999  eight=8888
    write (60,*) passnum,corrDxy
    if (inum .eq. 2) iendcnt=iendcnt+1
    if (inum .eq. 3) i3cnt=i3cnt+1
    if (inum .eq. 4) i4cnt=i4cnt+1
    if (inum .eq. 5) i5cnt=i5cnt+1
    if (inum .eq. 6) i6cnt=i6cnt+1
    if (inum .eq. 7) i7cnt=i7cnt+1
    if (inum .eq. 8) i8cnt=i8cnt+1
    if (inum .gt. 8) ibigcnt=ibigcnt+1
    return
end
c
c
c
c
    subroutine despikes (npts,outnum)
    real data(400,27),desdata(400,27),upper,lower
    integer ic(400),outnum,var
    common data(400,27)
    common /spike/ desdata(400,27),upper,lower,var
c
c----- this subroutine also provided by Tiku
c
c
c
c      PROGRAM DESPIKE
c*****
c      PROGRAM DESPIKE REMOVES MOST SPIKES FROM THE INPUT DATA SET.
c      HOWEVER, FOR BEST RESULTS, IT IS SUGGESTED TO RUN DESPIKE
c      AT LEAST THREE TIMES --- FOR EXAMPLE:
c
c          INPUT1  ---DESPIKE---> OUTPUT1
c      (OUTPUT1 = INPUT2) ---DESPIKE---> OUTPUT2
c      (OUTPUT2 = INPUT3) ---DESPIKE---> OUTPUT3.
c
c      STILL, AFTER RUNNING DESPIKE THREE TIMES, IT FAILS TO ELIMINATE
c      ORBITS WITH DISCONTINUOUS RESID VS LATITUDE PROFILES.
c      PROGRAM DEGAP ATTEMPTS TO TAKE CARE OF SUCH PASSES.
c
c
c      PARAMETERS TO CHECK: "UPPER" AND "LOWER" (IN NANOTESLAS):
c
c      IF PROGRAM DESPIKE HAS DETERMINED OBSERVATION N TO BE
c      A GOOD POINT, IT THEN SETS OUT TO DETERMINE IF POINT N+1
c      IS A GOOD POINT. IT DOES THIS BY CHECKING THE POINTS
c      N, N+1, AND N+2. OBSERVATION N+1 WILL BE A GOOD POINT
c      IF THE RESIDUAL DIFFERENCE BETWEEN POINT N+1 AND THE
c      POINT ABOVE IT (N OR N+2) IS LESS THAN "UPPER" AND
c      IF THE RESIDUAL DIFFERENCE BETWEEN IT AND THE POINT
c      BELOW IT (N+2 OR N) IS GREATER THAN "LOWER".
c*****
c
c      DO 2 I=1,400
c          IC(I)=1
c      2 CONTINUE
c
c*****
c      ARE THE FIRST NEW POINTS SPIKES?
c      NOTE: DATA(U,23) = RESID2(U)
c
c          I=1
c15  SL1=(DATA(I+1,var)-DATA(I,var))
c      SL2=(DATA(I+2,var)-DATA(I,var))
c      SL3=(DATA(I+3,var)-DATA(I,var))
c      SL4=(DATA(I+4,var)-DATA(I,var))
c      XSL=ABS(SL1+SL2+SL3+SL4)/4.0
c
c      S2=(DATA(I+2,var)-DATA(I+1,var))
c

```

```

      IF (ABS(SL1).GT.(3.0*XSL).OR.ABS(SL1).GT.(ABS(3.0*S2))) IC(I)=0
      IF (IC(I).EQ.0) THEN
        I=I+1
        GO TO 15
      ENDIF
C
C*****
C ARE THE MID POINTS SPIKES?
C
      DO 20 J=I,NPTS-2
        SL2=(DATA(J+1,var)-DATA(J+2,var))
        IF (SL1.GT.UPPER.AND.SL2.LT.LOWER) IC(J+1)=0
        IF (SL1.LT.LOWER.AND.SL2.GT.UPPER) IC(J+1)=0
        SL1=SL2
      20 CONTINUE
C
C*****
C IS THE LAST POINT A SPIKE?
C
      K=NPTS-2
      25 IF (IC(K).EQ.0) THEN
        K=K-1
        GO TO 25
      ENDIF
C
      SL1=ABS(DATA(K,var)-DATA(NPTS-1,var))
      SL2=ABS(DATA(NPTS-1,var)-DATA(NPTS,var))
      SL3=ABS(DATA(K,var)-DATA(NPTS,var))
      IF (IC(NPTS-1).EQ.0) THEN
        IF (SL1.GT.(3.0*SL2)) IC(NPTS)=0
        IF (SL3.GT.(3.0*UPPER)) IC(NPTS)=0
      ENDIF
      IF (IC(NPTS-1).EQ.1) THEN
        IF (SL2.GT.(3.0*SL1)) IC(NPTS)=0
      ENDIF
C
      NOBS=0
      DO 30 I=1,NPTS
        IF (IC(I).EQ.1) NOBS=NOBS+1
      30 CONTINUE
      WRITE(6,*) IDATA(1,1), NOBS
C
      outnum=0
      DO 35 I=1,NPTS
        IF (IC(I).EQ.1) THEN
          outnum=outnum+1
          do 32 m=1,27
            desdata(outnum,m)=data(i,m)
          32 continue
        35 CONTINUE
      C
      return
      END
C
C
C
      subroutine track (nf,innum,noc,nocgf)
      common /trax/ x(400),y(400)
C----- subroutine description
C      this subroutine calculates the lat lon coordinates of each point
C      to be plotted in tplot for a map view of the footprint of the pass
C
      RADFAC=0.017453293
      nop=innum
      if (nf .eq. 26) nocgf=nocgf+1
      if (nf .eq. 27) noc=noc+1
      DO 200 J=1,NOP
        x(j)=90.0-x(j)
        if (y(j).lt.0.) y(j)=y(j)+360.
        X(J)=X(J)*RADFAC
        Y(J)=Y(J)*RADFAC
      200 CONTINUE
      if (nf .eq. 26) WRITE (26) NOCGF,NOP, (X(J),Y(J),J=1,NOP)
      if (nf .eq. 27) WRITE (27) NOC,NOP, (X(J),Y(J),J=1,NOP)
C
      return
      end
C
C
C
C
      subroutine sqrfit (innum,x,ifitvar)
      real core(400),xmag(400),intpdata(400,27)
      common /intb/ intpdata(400,27)
C----- subroutine description
C      sqrfit fits the core field values to the observed data
C      in a least squares manner. that is, the subroutine finds
C      a value of x that is multiplied by all core field values

```

```

c      in a pass so that the core field model matches the
c      observed values closer.
c
c      x=0.0
c      cmean=0.0
c      fmean=0.0
c      do i=1,innum
c          core(i)=intpdata(i,16)
c          cmean=cmean+core(i)
c          xmag(i)=intpdata(i,ifitvar)
c          fmean=fmean+xmag(i)
c      enddo
c
c      cmean=cmean/real(innum)
c      fmean=fmean/real(innum)
c
c      do i=1,innum
c          xmag(i)=xmag(i)-fmean
c          core(i)=core(i)-cmean
c      enddo
c
c      ctc=0.0
c      do 600 i=1,innum
600      ctc=(core(i)*core(i))+ctc
c
c      ctcinv=1.0/ctc
c
c      ctf=0.0
c      do 700 i=1,innum
700      ctf=(core(i)*xmag(i))+ctf
c
c      x=ctcinv*ctf
c
c      do 800 i=1,innum
800      intpdata(i,ifitvar)=xmag(i)-(core(i)*x)
c
c
c      999 continue
c      return
c      end

```



```

program movetrunc
integer xrow,xcol,zero,eight,xpassno,ypassno,ycol,
> x3row,x3col,x3pass,y3row,y3col,y3pass,yrow,
> strcnt,nobs,dndk,tcount,paircnt,nowant(4000),nocnt,
> paircnt1,jstop,minobs,passrem,totpass,global,
> outto,nopass,type,noc
real xmean,ymean,x3data(400,3),y3data(400,3),y3mean,
> xldata(400),yldata(400),xadata(400,4),ybdata(400,4),
> x3mean,xamean,ybmean,x(400),y(400)
character*80 filename
common /tplot/ x(400),y(400)
common /nope/ nowant(4000),nocnt
common /trunstat/ xadata(400,4),ybdata(400,4)
common /rowcol/ x3row,y3row,xrow,yrow,x3col,y3col,xcol,ycol,
> x3mean,y3mean,xmean,ymean,x3pass,y3pass,
> xpassno,ypassno
common x3data(400,3),xldata(400),y3data(400,3),yldata(400)

c----- program description
c
c this program truncates, in the time domain, two adjacent passes
c to the same length. this program should be used only after the
c passes have been reordered by program reorder. truncation is
c accurate in the time domain rather than in the frequency domain.
c this program is used before program fourier which is used to
c extract the similar wavelengths of adjacent passes.
c
c program date: 16 apr 91
c
c write (*,*) 'INPUT FILE X OF LAT-LONG-RAD DATA'
c read (*,9990) filename
9990 format(a80)
c open (10, file=filename,status='old',form='unformatted')
c write (*,*) 'INPUT FILE X OF MAGNETIC VARIABLES'
c read (*,9990) filename
c open (11, file=filename,status='old',form='unformatted')
c
c write (*,*) '0 IF THE DATA IS GLOBAL OR POLAR'
c write (*,*) '1 IF THE DATA DOES NOT INCLUDE ALL LONGITUDES'
c read (*,*) global
c if (global .eq. 0) then
c   write (*,*) 'NOTE: FILE Y WILL HAVE THE FIRST PASS MOVED'
c   write (*,*) 'TO THE BOTTOM OF THE FILE'
c   write (*,*) ' '
c elseif (global .eq. 1) then
c   write (*,*) 'NOTE: OUTPUT FILE X WILL NOT INCLUDE THE LAST PASS'
c   write (*,*) ' '
c   write (*,*) ' '
c   write (*,*) ' '
c endif
c
c write (*,*) 'OUTPUT FILE X OF TRUNCATED LAT-LONG-RAD DATA'
c read (*,9990) filename
c open (20, file=filename,form='unformatted')
c write (*,*) 'OUTPUT FILE X OF TRUNCATED MAGNETIC VARIABLES'
c read (*,9990) filename
c open (21, file=filename,form='unformatted')
c write (*,*) 'OUTPUT FILE Y OF TRUNCATED LAT-LONG-RAD DATA'
c read (*,9990) filename
c open (22, file=filename,form='unformatted')
c write (*,*) 'OUTPUT FILE Y OF TRUNCATED MAGNETIC VARIABLES'
c read (*,9990) filename
c open (23, file=filename,form='unformatted')
c write (*,*) 'OUTPUT FILE OF TRACK PROFILES TO BE RUN IN TPLLOT'
c read (*,9990) filename
c open (24, file=filename,form='unformatted')
c write (*,*) 'OUTPUT FILE OF STATISTICS'
c read (*,9990) filename
c open (25, file=filename,form='formatted')
c
c write (*,*) '0 IF THESE ARE DUSK DATA SETS'
c write (*,*) '1 IF THESE ARE DAWN DATA SETS'
c read (*,*) dndk
c write (*,*) '0 IF ALL PASSES ARE WANTED'
c write (*,*) '1 IF SOME PASSES SHOULD BE REMOVED'
c read (*,*) nocnt
c if (nocnt .eq. 1) then
c   write (*,*) 'INPUT FILE OF PASS NUMBERS NOT WANTED'
c   read (*,9990) filename
c   open (26, file=filename,status='old',form='formatted')
c   do 10 i=1,4000
c     read (26,*,end=15) nowant(i)
10   continue
15   continue
c   nocnt=i-1
c endif
c write (*,*) 'MINIMUM NUMBER OF OBSERVATIONS FOR EACH PASS'
c read (*,*) minobs
c write (*,*) 'TYPE OF GAP FINDER (2)'
c write (*,*) '1 FOR ONLY FINDING GAPS'
c write (*,*) '2 FOR USING THE MINIMUM OBSERVATIONS'

```

```

      read (*,*) type
c
      write (*,*) '-----'
      write (*,*) 'running through dataset to find passes',
>      ' that do not overlap'
c
c----- subroutine findgap locates passes that do not
c      have overlapping segments and removes the
c      shorter of the two passes. the subroutine
c      continues reading and rereading the dataset
c      until all non-overlapping segments are removed
c
      call findgap (global,dndk,minobs,type)
      write (*,*) 'done with run through'
      write (*,*) '-----'
c
      write (25,*) 'XPASS YPASS CCD      CCY      XVAR      YVAR ',
>      'COVARXY  XSTDEV  YSTDEV'
      write (25,*) '      XMEAN  YMEAN      XSLOPE  YSLOPE',
>      '      XINTCPT  YINTCPT'
      paircnt=0
      paircnt1=0
      tcount=0
      strcnt=0
      jstop=0
      passrem=0
      totpass=0
c
30  continue
      read (10,end=90) y3row,y3col,zero,y3mean,y3pass,eight
      do 35 i=1,y3row
         read (10) (y3data(i,i),i=1,y3col)
35  continue
      read (11) yrow,ycol,zero,ymean,ypassno,eight
      do 45 i=1,yrow
         read (11) yldata(i)
45  continue
      totpass=totpass+1
      if (yrow.lt.minobs .or. y3row.lt.minobs) then
         write (*,*) y3pass,ypassno, ' PASS REMOVED: ROWS=',y3row,yrow
         passrem=passrem+1
         go to 30
      endif
      if (nocnt .eq. 0) go to 55
      do 50 i=1,nocnt
         if (ypassno .eq. nowant(i)) then
            write (*,*) ypassno,y3pass, ' PASS REMOVED'
            passrem=passrem+1
            go to 30
         endif
50  continue
55  continue
      go to 95
c----- this little jump around is used
c      to get the last and first passes
c
      of global datasets truncated
90  jstop=1
      if (global .eq. 1) go to 999
c
95  continue
      strcnt=strcnt+1
c----- offset the data file in subroutine
c      movtrun
      if (strcnt .eq. 1) call movtrun (-1,outto,jstop)
      if (strcnt .gt. 1) call movtrun (0,outto,jstop)
      if (outto) 30,100,100
c----- truncate the passes to the same length
100 continue
      nopass=0
      call truncate (xrow,yrow,dndk,nobs,paircnt1,nopass,
>      xpassno,ypassno)
      if (nopass .gt. 0) then
c----- if this happens, then subroutine
c
      findgap didn't work just right
      write (*,*) 'OH MAN HAVE YOU GOT TROUBLE NOW'

      stop
      endif
c----- do a little statistical nonsense
c
      call statistics (nobs,xpassno,ypassno,xamean,ybmean)
c

```

```

c-----write out the truncated lengths of passes
c
  write (20) nob3,x3col,zero,xamean,xpassno,eight
  write (21) nob3,xcol,zero,xamean,xpassno,eight
  write (22) nob3,y3col,zero,ybmean,ypassno,eight
  write (23) nob3,ycol,zero,ybmean,ypassno,eight
  do 200 j=1,nob3
    write (20) xadata(j,1),(xadata(j,1),i=3,4)
    write (21) xadata(j,2)
    write (22) ybdata(j,1),(ybdata(j,1),i=3,4)
    write (23) ybdata(j,2)
200 continue
c
  call track (nob3,noc)
  WRITE (24) NOC,NOB3,(X(J),Y(J),J=1,NOB3)
c
  if (paircnt1 .gt. 0) tcount=tcount+1
  paircnt=paircnt+paircnt1
  if (jstop .eq. 1) go to 999
c
  call movtrun (1,outto,jstop)
  if (outto) 30,999,999
c
c
999 continue
  if (global .eq. 1) strcnt=strcnt-1
  write (*,*) 'corrected',paircnt,' pairs of latitudes in'
  write (*,*) tcount,' passes to beginning lengths'
  write (*,*) 'total passes read = ',totpass
  write (*,*) 'removed',passrem,' passes from processing'
  write (*,*) 'total passes written = ',strcnt
  close (10)
  close (11)
  close (20)
  close (21)
  close (22)
  close (23)
  close (25)
  stop
  end
c
c
c
  subroutine truncate (xrow,yrow,dndk,minrow,stocount,nopass,
>    xpassno,ypassno)
> integer xrow,yrow,stocount,row1,rowinc,minrow,nocnt,
>    dndk,nopass,minxyrow,nowant(4000),xpassno,ypassno
> real xdata(400,4),ydata(400,4),
>    x3data(400,3),x1data(400),y3data(400,3),y1data(400),
>    adata,bdata,diffab,abss,xadata(400,4),ybddata(400,4)
> common /trunstat/ xadata(400,4),ybddata(400,4)
> common /nope/ nowant(4000),nocnt
> common x3data(400,3),x1data(400),y3data(400,3),y1data(400)
c----- subroutine description
c
  this subroutine truncates two sets of values to the same length.
  truncation is based on the independent variable which is the
  latitude of each point along a pass. these values must be
  interpolated to every 0.33 degrees.
c
  do 70 j=1,xrow
    xdata(j,1)=x3data(j,1)
    xdata(j,2)=x1data(j)
    xdata(j,3)=x3data(j,2)
    xdata(j,4)=x3data(j,3)
70 continue
  do 75 j=1,yrow
    ydata(j,1)=y3data(j,1)
    ydata(j,2)=y1data(j)
    ydata(j,3)=y3data(j,2)
    ydata(j,4)=y3data(j,3)
75 continue
c
80 continue
  stocount=0
  jj=1
  row1=xrow
  rowinc=yrow
c-----loops from 90 to 200 increment through the
c      two input passes and truncate the lengths
c      to the same length
90 continue
  adata=xdata(jj,1)
  bdata=ydata(jj,1)
  diffab=adata-bdata
  abss=abs(diffab)
  if (row1 .eq. 0 .or. rowinc .eq. 0) then
    minxyrow=min(xrow,yrow)
    if (minxyrow .eq. xrow) then

```



```

        nopass=xpassno
        nowant(nocnt+1)=xpassno
        write (*,*) 'xrows (ii) =',rowii,' yrows (inc) =',rowinc
        write (*,*) 'rerunning to remove x pass number =',xpassno
        write (*,*) 'xrow =',xrow,' yrow =',yrow
        return
    elseif (minxyrow .eq. yrow) then
        nopass=ypassno
        nowant(nocnt+1)=ypassno
        write (*,*) 'xrows (ii) =',rowii,' yrows (inc) =',rowinc
        write (*,*) 'rerunning to remove y pass number =',ypassno
        write (*,*) 'xrow =',xrow,' yrow =',yrow
        return
    endif
endif
minrow=min(rowii,rowinc)
c   write (*,*) rowii,rowinc,minrow
c   write (*,*) adata,bdata,abss
c-----if pass a (ii) matches pass b (inc) at
c           beginning length then write to xdata and
c           ydata and race to main program
    if (abss .lt. 0.33) then
        do 110 ll=1,minrow
            do 110 kk=1,4
                xadata(ll,kk)=xdata(ll,kk)
                ybdata(ll,kk)=ydata(ll,kk)
                write (*,*) xdata(ll),ydata(ll)
c 110      continue
            return
        endif
c-----if pass a no matcha the b data then find new
c           a or b depending on whether or not ascending
c           or descending order of independent variable
    if (abss .ge. 0.33) then
        stocount=stocount+1
c-----if this is a dusk pass then will count from
c           -90.0 lat degrees toward the equator
        if (dndk .eq. 0) then
            if (xdata(jj,1) .gt. ydata(jj,1)) then
                rowinc=rowinc-1
                do 130 mm=1,rowinc
                    do 130 kk=1,4
                        ydata(mm,kk)=ydata(mm+1,kk)
                        write (*,*) ydata(mm,kk)
c 130      continue
                    elseif (xdata(jj,1) .lt. ydata(jj,1)) then
                        rowii=rowii-1
                        do 150 nn=1,rowii
                            do 150 kk=1,4
                                xdata(nn,kk)=xdata(nn+1,kk)
c 150      continue
                            endif
                        endif
c-----if this is a dawn pass then will count from
c           the equator toward the south pole
c           that is decreasing independent variable
                    elseif (dndk .eq. 1) then
                        if (xdata(jj,1) .lt. ydata(jj,1)) then
                            rowinc=rowinc-1
                            do 160 mm=1,rowinc
                                do 160 kk=1,4
                                    ydata(mm,kk)=ydata(mm+1,kk)
                                    write (*,*) ydata(mm,kk)
c 160      continue
                                elseif (xdata(jj,1) .gt. ydata(jj,1)) then
                                    rowii=rowii-1
                                    do 170 nn=1,rowii
                                        do 170 kk=1,4
                                            xdata(nn,kk)=xdata(nn+1,kk)
c 170      continue
                                        endif
                                    endif
                                endif
                            endif
                        endif
                    endif
                go to 90
            end
        end
        c
        c
        c
        c
        subroutine statistics (minrow,xpassno,ypassno,xamean,ybmean)
        integer minrow,nobs,xpassno,ypassno
        real xadata(400,4),ybdata(400,4),nobss
        common /trunstat/ xadata(400,4),ybdata(400,4)
        c
        c           the statistical calculations using two
        c           references:
        c           1) Davis, Statistics and Data Analysis in
        c               Geology, 2nd ed., 1986 pp. 41
        c           2) Young, Statistical Treatment of Experi-

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c                                mental Data, 1962, McGraw Hill, 115-132
c
c-----loops that sum x, x**2, y, y**2 and xy
c                                and calculate new truncate means
      nobss=minrow
      nobss=float(nobss)
      xsum=0.0
      xsumsq=0.0
      ysum=0.0
      ysumsq=0.0
      sumxy=0.0
      do 240 j=1,nobss
        xsum=xsum+xdata(j,2)
        xsumsq=xsumsq+(xdata(j,2))**2
        ysum=ysum+ydata(j,2)
        ysumsq=ysumsq+(ydata(j,2))**2
        sumxy=sumxy+(xdata(j,2)*ydata(j,2))
240      continue
c      write (*,*) xsum,ysum,xsumsq,ysumsq,sumxy
c-----find corrected sum of products, covariance
c                                and corrected sum of squares (x) (y)
c
      xmean=xsum/nobss
      ymean=ysum/nobss
      sumprod=sumxy-((xsum*ysum)/nobss)
      covarxy=sumprod/(nobss-1.0)
      xcsumsq=xsumsq-((xsum**2)/nobss)
      ycsumsq=ysumsq-((ysum**2)/nobss)
c
c-----find variance, standard deviation for x and y
c
      xvar=xcsumsq/(nobss-1.0)
      yvar=ycsumsq/(nobss-1.0)
      xstdev=sqrt(xvar)
      ystdev=sqrt(yvar)
c-----find correlation coefficient by Davis method
      corrDxy=covarxy/(xstdev*ystdev)
c-----find slopes, intercepts and correlation
c                                coefficient by Young method
      xslope=((nobss*sumxy)-(xsum*ysum))/((nobss*xsumsq)-xsum**2)
      yslope=((nobss*sumxy)-(xsum*ysum))/((nobss*ysumsq)-ysum**2)
      xintcpt=((ysum*xsumsq)-(sumxy*xsum))/((nobss*xsumsq)-xsum**2)
      yintcpt=((xsum*ysumsq)-(sumxy*ysum))/((nobss*ysumsq)-ysum**2)
      corrYxy=sqrt(xslope*yslope)
c
c-----write out this mess for individual pass and
c                                overlapping lengths of passes
c
c      write (25,9992) xpassno,ypassno,xvar,yvar,xstdev,ystdev,
c      > xmean,ybmean
9992 format ('FOR OVERLAPPING LENGTHS  X=',i5,' Y=',i5,/,
c      > 'X VARIANCE=',f9.3,' Y VARIANCE=',f9.3,' X STDEV=',
c      > f9.3,' Y STDEV=',f9.3,' XMEAN=',f9.3,' YMEAN=',f9.3)
c      write (25,9993) covarxy,corrDxy
9993 format ('COVARIANCE XY=',f9.3,' Davis CORRELATION COEF=',f9.3)
c      write (25,9994) xslope,xintcpt,yslope,yintcpt,corrYxy
9994 format ('X SLOPE=',f9.3,' X INTERCEPT=',f9.3,' Y SLOPE=',
c      > f9.3,' Y INTERCEPT=',f9.3,' Young CORRELATION COEF=',
c      > f9.3,/)
c
c      write (25,9995) xpassno,ypassno,corrDxy,corrYxy,xvar,yvar,
c      > covarxy,xstdev,ystdev
9995 format (2i5,7(f10.4))
c      write (25,9996) xmean,ybmean,xslope,yslope,xintcpt,yintcpt
9996 format (10x,6(f10.4))
c      return
c      end
c
c      subroutine movtrun (into,outto,jstop)
c      integer into,outto,sy3row,syrow,sy3col,sycol,
c      > sy3pass,sypassno,jstop,
c      > y3row,yrow,y3col,ycol,y3pass,ypassno,
c      > x3row,xrow,x3col,xcol,x3pass,xpassno,
c      > sx3row,sxrow,sx3col,sxcol,sx3pass,sxpassno
c      real x3data(400,3),xldata(400),y3data(400,3),yldata(400),
c      > sy3mean,symean,savey3(400,3),savey1(400),y3mean,
c      > ymean,x3mean,xmean,storex3(400,3),storex1(400),
c      > sx3mean,sxmean
c      common x3data(400,3),xldata(400),y3data(400,3),yldata(400)
c      common /rowcol/ x3row,y3row,xrow,yrow,x3col,y3col,xcol,ycol,
c      > x3mean,y3mean,xmean,ymean,x3pass,y3pass,
c      > xpassno,ypassno
c
c----- subroutine description
c      this subroutine stores one pass so that the offset
c      will occur.
c      if (jstop) 10,10,350
10    if (into) 40,85,290

```

```

c
40  continue
    do 50 i=1,y3row
        do 55 ii=1,y3col
            savey3(i,ii)=y3data(i,ii)
55      continue
        savey1(i)=y1data(i)
50  continue
    sy3row=y3row
    syrow=yrow
    sy3col=y3col
    sycol=ycol
    sy3mean=y3mean
    symean=ymean
    sy3pass=y3pass
    sypassno=y3passno
c
    do 70 i=1,y3row
        do 75 ii=1,y3col
            x3data(i,ii)=y3data(i,ii)
75      continue
        x1data(i)=y1data(i)
70  continue
    x3row=y3row
    xrow=yrow
    x3col=y3col
    xcol=ycol
    x3mean=y3mean
    xmean=ymean
    x3pass=y3pass
    xpassno=y3passno
c
    outto = -1
    return
c
c
85  continue
    do 90 i=1,y3row
        do 95 ii=1,y3col
            storex3(i,ii)=y3data(i,ii)
95      continue
        storex1(i)=y1data(i)
90  continue
    sx3row=y3row
    sxrow=yrow
    sx3col=y3col
    sxcol=ycol
    sx3mean=y3mean
    sxmean=ymean
    sx3pass=y3pass
    sxpassno=y3passno
c
    if (xrow.ne.x3row .or. xpassno.ne.x3pass .or.
>      yrow.ne.y3row .or. ypassno.ne.y3pass) then
        write (*,*) 'WACKO, TRA-LA-LA, JOLLY-GOOD, NO MATCH BETWEEN'
        write (*,*) 'ROWS OR PASSNOS' X= ',xrow,x3row,xpassno,x3pass
        write (*,*) 'Y= ',yrow,y3row,ypassno,y3pass
        stop
    endif
c
    outto = 0
    return
c
c
290 continue
    x3row=sx3row
    xrow=sxrow
    x3col=sx3col
    xcol=sxcol
    x3mean=sx3mean
    xmean=sxmean
    x3pass=sx3pass
    xpassno=sxpassno
    do 300 i=1,x3row
        do 305 ii=1,x3col
            x3data(i,ii)=storex3(i,ii)
305      continue
        x1data(i)=storex1(i)
300  continue
c
    outto = -1
    return
c
c
350 continue
    do 360 i=1,sy3row
        do 365 ii=1,sy3col
            y3data(i,ii)=savey3(i,ii)
365      continue
        y1data(i)=savey1(i)

```

```

360 continue
    y3row=sy3row
    yrow=syrow
    y3col=sy3col
    ycol=sycol
    y3mean=sy3mean
    ymean=symean
    y3pass=sy3pass
    ypassno=sypassno
c
    outto = 0
    return
c
end
c
c
c
c
    subroutine findgap (global,dndk,minobs,type)
    integer zero,eight,minxyrow,xrow,yrow,type,
>    y3row,y3col,y3pass,xcnt,ycnt,stmincnt,
>    dndk,nowant(4000),nocnt,xpassno,ypassno,
>    minobs,totpass,global,both,nocnt2,
>    nopass,stmnocnt,allcnt
    real y3data(400,3),y3mean,abss,alldata(4000,4)
    common /nope/ nowant(4000),nocnt
c----- subroutine description
c    findgap locates two adjacent passes that do not have
c    any common overlapping segment. if it finds two such
c    passes, then it removes the shorter of the two, continues
c    running through the remainder of the data while searching
c    for non-overlapping passes, and finally reruns through
c    the data set to assure that all non-overlapping passes
c    have been located.
c
    totpass=0
    allcnt=0
    stmnocnt=nocnt
c----- read through the data only once and
c    store the pass number, first lat and
c    last lat in array alldata
30 continue
    read (10,end=60) y3row,y3col,zero,y3mean,y3pass,eight
    do 35 i=1,y3row
        read (10) (y3data(i,1),i=1,y3col)
35 continue
    totpass=totpass+1
    if (y3row .lt. minobs) go to 30
    if (nocnt .eq. 0) go to 55
    do 50 i=1,nocnt
        if (y3pass .eq. nowant(i)) go to 30
50 continue
55 continue
    allcnt=allcnt+1
    alldata(allcnt,1)=real(y3pass)
    alldata(allcnt,2)=real(y3row)
    alldata(allcnt,3)=y3data(1,1)
    alldata(allcnt,4)=y3data(y3row,1)
    go to 30
60 continue
c----- depending on the type of gap
c
    finder chosen, the program
c
c    if (type .eq. 2) go to 400
c
c    will proceed as appropriate
70 continue
    jstop=0
c----- xcnt and ycnt represent the two
c    adjacent passes
    xcnt=1
    ycnt=2
c----- the next two if statements check
c    if one of the two adjacent passes
c    is not wanted
    if (nocnt .eq. 0) go to 100
    do 80 i=1,nocnt
        if (int(alldata(xcnt,1)) .eq. nowant(i)) then
            do 90 jj=xcnt,allcnt-1
                do 90 j=1,4
                    alldata(jj,j)=alldata(jj+1,j)
90 continue
                allcnt=allcnt-1
                go to 70
            endif
80 continue
c
100 continue
    if (nocnt .eq. 0) go to 140

```

```

do 110 i=1,nocnt
  if (int(alldata(ycnt,1)) .eq. nowant(i)) then
    if (ycnt+1 .gt. allcnt) then
      ycnt=ycnt+1
      go to 195
    elseif (jstop .eq. 1) then
      ycnt=ycnt+1
      go to 100
    endif
    do 105 jj=ycnt,allcnt-1
      do 105 j=1,4
        alldata(jj,j)=alldata(jj+1,j)
105      continue
      allcnt=allcnt-1
      go to 100
    endif
110  continue
140  continue
  both=0
  abss=abs(alldata(xcnt,3)-alldata(ycnt,3))
  if (abss .lt. 0.33) go to 190
  if (abss .ge. 0.33) then
c----- truncation time!
    xrow=int(alldata(xcnt,2))
    yrow=int(alldata(ycnt,2))
    xpassno=int(alldata(xcnt,1))
    ypassno=int(alldata(ycnt,1))
    minxyrow=min(xrow,yrow)
    nopass=xpassno
    if (minxyrow .eq. yrow) nopass=ypassno
    if (xrow .eq. yrow) both=1
    nocnt2=nocnt
c-----if this is a dusk pass then will count from
c      -90.0 lat degrees toward the equator
    if (dndk .eq. 0) then
      if (alldata(xcnt,3) .gt. alldata(ycnt,3)) then
        if (alldata(xcnt,3) .gt. alldata(ycnt,4)) then
          nocnt=nocnt+1
          nowant(nocnt)=nopass
        endif
      elseif (alldata(xcnt,3) .lt. alldata(ycnt,3)) then
        if (alldata(xcnt,4) .lt. alldata(ycnt,3)) then
          nocnt=nocnt+1
          nowant(nocnt)=nopass
        endif
      endif
c-----if this is a dawn pass then will count from
c      the equator toward the south pole
c      that is decreasing independent variable
    elseif (dndk .eq. 1) then
      if (alldata(xcnt,3) .lt. alldata(ycnt,3)) then
        if (alldata(xcnt,3) .lt. alldata(ycnt,4)) then
          nocnt=nocnt+1
          nowant(nocnt)=nopass
        endif
      elseif (alldata(xcnt,3) .gt. alldata(ycnt,3)) then
        if (alldata(xcnt,4) .gt. alldata(ycnt,3)) then
          nocnt=nocnt+1
          nowant(nocnt)=nopass
        endif
      endif
    endif
    if (nocnt .gt. nocnt2 .and. both .eq. 1) then
      nocnt=nocnt+1
      nowant(nocnt)=xpassno
    endif
  endif
c
190  continue
  xcnt=ycnt
  ycnt=ycnt+1
  if (jstop .eq. 1) go to 200
195  if (ycnt .gt. allcnt) then
    if (global .eq. 1) go to 200
    ycnt=1
    jstop=1
  endif
  go to 100
c
200  continue
  if (nocnt .eq. strnocnt) go to 999
  if (strnocnt .lt. nocnt) then
    strnocnt=nocnt
    go to 70
  endif
c
c
400  continue
  mincnt=0
  strmincnt=mincnt

```

```

c
470 continue
jstop=0
c----- xcnt and ycnt, see notes above
xcnt=1
ycnt=2
if (int(alldata(xcnt,2)) .lt. minobs) then
do 490 jj=xcnt,allcnt-1
do 490 j=1,4
alldata(jj,j)=alldata(jj+1,j)
490 continue
allcnt=allcnt-1
go to 470
endif
c
500 continue
if (int(alldata(ycnt,2)) .lt. minobs) then
if (ycnt+1 .gt. allcnt) then
ycnt=ycnt+1
go to 595
elseif (jstop .eq. 1) then
ycnt=ycnt+1
go to 500
endif
do 505 jj=ycnt,allcnt-1
do 505 j=1,4
alldata(jj,j)=alldata(jj+1,j)
505 continue
allcnt=allcnt-1
go to 500
endif
510 continue
540 continue
abss=abs(alldata(xcnt,3)-alldata(ycnt,3))
if (abss .lt. 0.33) go to 590
if (abss .ge. 0.33) then
xrow=int(alldata(xcnt,2))
yrow=int(alldata(ycnt,2))
minxyrow=min(xrow,yrow)
mincnt2=mincnt
c-----if this is a dusk pass then will count from
c -90.0 lat degrees toward the equator
if (dndk .eq. 0) then
if (alldata(xcnt,3) .gt. alldata(ycnt,3)) then
if (alldata(xcnt,3) .gt. alldata(ycnt,4)) mincnt=mincnt+1
elseif (alldata(xcnt,3) .lt. alldata(ycnt,3)) then
if (alldata(xcnt,4) .lt. alldata(ycnt,3)) mincnt=mincnt+1
endif
c-----if this is a dawn pass then will count from
c the equator toward the south pole
c that is decreasing independent variable
elseif (dndk .eq. 1) then
if (alldata(xcnt,3) .lt. alldata(ycnt,3)) then
if (alldata(xcnt,3) .lt. alldata(ycnt,4)) mincnt=mincnt+1
elseif (alldata(xcnt,3) .gt. alldata(ycnt,3)) then
if (alldata(xcnt,4) .gt. alldata(ycnt,3)) mincnt=mincnt+1
endif
endif
if (mincnt .gt. mincnt2) minobs=minxyrow+1
endif
c
590 continue
xcnt=ycnt
ycnt=ycnt+1
if (jstop .eq. 1) go to 600
595 if (ycnt .gt. allcnt) then
if (global .eq. 1) go to 600
ycnt=1
jstop=1
endif
go to 500
c
600 continue
if (mincnt .eq. strmincnt) go to 999
if (strmincnt .lt. mincnt) then
strmincnt=mincnt
go to 470
endif
c
999 continue
write (*,*) 'total passes read = ',totpass
if (nocnt .gt. 0) then
write (*,*) 'will remove the following passes from processing'
do 1010 i=1,nocnt
write (*,*) nowant(i),i
1010 continue
endif
if (type .eq. 2) write (*,*) 'new minimum observation cutoff',
> ' is =',minobs
rewind (10)

```

```

c      return
c      end
c
c
c      subroutine track (nop,noc)
c      integer nop,noc
c      real radfac,x(400),y(400),xadata(400,4),yadata(400,4)
c      common /tplot/ x(400),y(400)
c      common /trunstat/ xadata(400,4),yadata(400,4)
c----- subroutine description
c      track stores the lat and long coordinates of each
c      data point along a pass. these coordinates are then
c      used to plot with a graphics package, the track footprint
c      of the satellite.
c      NOTE: the lat and long values are converted to radian values
c      because the plotting package that i work with utilizes
c      radians.
c      RADFAC=0.017453293
c      noc=noc+1
c      do 300 j=1,nop
c          x(j) = 90.0 - xadata(j,1)
c          y(j) = xadata(j,3)
c          if (y(j) .lt. 0.0) y(j) = y(j) + 360.0
c          x(j) = x(j) * radfac
c          y(j) = y(j) * radfac
300 continue
c
c      return
c      end

```





```

program fourier1d
character*80 filename
real xdata(4096),ydata(4096),xmean,ymean,minccin,
> prcnt,delta,cuthi,cutlo,xlag,mincc,maxcc,short,long,
> maxccin,cxlag,strtdata(4096)
integer xpassno,ypassno,zero,eight,file,xcol,xrow,ycol,yrow,
> trnsf,lhb,cc,trnsb,npass,imean,cnwind,seven,
> nwind,numfile,nxout,nyout,match,gfent,xnobs,ynobs
complex xcdata(4096),ycdata(4096)
common /rowcol/ xnobs,ynobs
common /ffttfft/ nobbs,prcnt,imean,fold
common /lhbflt/ delta,cuthi,cutlo,xlag,npass,nwind
common /ccflt/ mincc,maxcc,match,minccin,maxccin,cnwind,cxlag
common /reals/ xdata,ydata
common /comps/ xcdata,ycdata
c
c-----program description
c
c fourier1d is an all encompassing fourier analysis program!
c subroutines include the fft for forward and inverse situations,
c a bandpass filter which can be adjusted to perform low, high and
c bandpass filtering of wave numbers and a correlation coefficient
c filter which zeros out wavenumbers according to correlation
c coefficients. both the bandpass filter and the correlation
c coefficient filter provide the user with several windowing options
c (as well as no windowing option) to smooth wavenumbers prior
c to inverse transformation. both filters use the same subroutine
c to window in the TIME (real number data) domain. with respect to
c run time considerations: if many different datasets are submitted
c at the same time to the program, it will still calculate the same
c BANDPASS windowing function for each dataset every time it
c encounters a new dataset. since this windowing function need only
c be calculated once, it causes the program to do needless work. i
c hope to soon remedie this little time consuming "bug". big note of
c caution: the windowing function will change with each new dataset
c for the CORRELATION FILTER and therefore, leave it alone!!
c
c NOTE: ANY fourier analysis routine can be inserted
c to this program as a subroutine. maybe i'll put in
c such features as upward continuation, etc..
c NOTE: the only data variables absolutely necessary as INPUT are
c the number of observations of input profile, the remaining
c variables; zero,mean,pass-number and eight, are not needed.
c but, mean can be an OUTPUT if desired.
c
c updates:
c 30 Jan 91
c this update pertained to removing calls to differing fft2d
c subroutines so that now all calls are to the same fft2d
c subroutine. and more importantly, now the fft2d routines
c will handle 1 row of data so that the bandpass filter works
c correctly. and even more importantly the zero filling option
c now zero fills such that the data is located in the middle
c of all those wonderful zeros. and for those of you who are
c really into this, you can now fold out a percentage of the
c edge of your data, smooth the folded out part to zero, fft,
c filter, and ifft such that edge effects are minimized.
c ohh boy!!
c
c 9 jul 92:
c major revisions changing code from two-dimensionally based
c ffts to one-dimensional ffts. revisions include removal of
c subroutines transpo and store. major changes to subroutines
c fft2d (which is now known as fft1d), datwnd, bndpas and
c window. now there is no longer a need for transposing the
c arrays so that run time should be decreased.
c NOTE: i removed a great deal of comments at the beginning of
c the subroutines. all removed comments discussed the
c two dimensional sense of the routine. i added comments
c dealing specifically with the one dimensional changes.
c
c
c write (*,*) '0 IF YOU HAVE A FILE OF ALL VARIABLES'
c write (*,*) '1 IF YOU WANT TO TYPE THEM INTERACTIVELY -- ha ha'
c read (*,*) file
c if (file .eq. 0) then
c write (*,9988)
9988 format ('USE THE FOLLOWING ORDER FOR INPUT FILE'//,
> 'IF VARIABLE DOES NOT APPLY INPUT ANY BOGUS NUMBER'//,
> 'numfile'//,
> 'lhb cc'//,
> 'nobbs fold prcnt imean'//,
> 'delta short long npass'//,
> 'nwind xlag'//,
> 'mincc maxcc match minccin maxccin cnwind cxlag'//,
> 'isub'//)
c write (*,*) 'INPUT FILE OF VARIABLES'
c read (*,9990) filename
c open (22, file=filename, form='formatted',status='old')
c go to 100

```

```

        elseif (file .eq. 1) then
            go to 50
        elseif (file .ne. 0 .or. file .ne. 1) then
            write (*,*) 'HEY HEY HEY ITS BAD FILE NUMBER AND YOU GOT'
            write (*,*) 'TO MAKE A NEW CHOICE TOOOOOOO -- to the tune of'
            write (*,*) 'fat albert'
            go to 999
        endif
c
50    continue
    write (*,9989)
9989 format ('1 IF YOU HAVE ONLY ONE FILE TO BE FOURIERED',//,
>          '2 IF YOU HAVE TWO FILES TO BE COMPARED')
    read (*,*) numfile
c
    write (*,9991)
9991 format ('1 FOR ONLY LOW-HIGH-BAND FILTER THE DATA'//,
>          '2 FOR L-H-B FILTER THEN C-C FILTER THE DATA'//,
>          '3 FOR L-H-B THEN C-C THEN L-H-B FILTER THE DATA'//,
>          '4 FOR C-C FILTER THEN L-H-B FILTER THE DATA'//,
>          '5 FOR C-C THEN L-H-B THEN C-C FILTER THE DATA'//,
>          '6 DO NOT FILTER THE DATA'//,
>          '1 FOR ONLY CORRELATION COEFFICIENT FILTER THE DATA'//,
>          '2 DO NOT C-C FILTER THE DATA'//,
>          'choose 2 if 5 or less was chosen above'//,
>          'lhb cc')
    read (*,*) lhb,cc
c
    write (*,9992)
9992 format ('THE FOLLOWING REFERS TO FFT AND IFFT'//,
>          'NUMBER OF OBSERVATIONS FOR FFT ARRAY'//,
>          'AT A POWER OF 2: (256) (2 16 32 64 128 256 etc)'//,
>          'PERCENT OF DATA TO BE FOLDED OUT (0.1 TO 99.9)'//,
>          'PERCENT OF EACH EDGE OF INPUT ARRAY OR FOLDED'//,
>          'OUT ARRAY TO BE SMOOTHED TO ZERO (0.1 TO 49.9)'//,
>          '0 DO NOT ADD MEAN TO IFFT DATA'//,
>          '1 ADD MEAN OF INPUT DATA TO OUTPUT IFFT DATA'//,
>          'nobs fold prcnt imean')
    read (*,*) nobs,fold,prcnt,imean
c
    if (nobs .gt. 4096) then
        write (*,8999) nobs
8999 format (1x,'SORRY',16,1x,'IS GREATER THAN 4096 THE',
>          'SIZE OF ARRAYS SET'/' IN THE SOURCE CODE ',
>          'YOU NEED TO ACCESS SOURCE CODE AND MAKE CHANGES')
        go to 999
    endif
c
    if (lhb .lt. 6) then
        write (*,9993)
9993 format ('DELTA.....GRID INTERVAL IN MAP UNITS (0.33 degrees)'//,
>          'SHORT.....SHORTEST WAVELENGTH TO BE PASSED'//,
>          'MUST BE AT LEAST 2*DELTA (0.66 degrees)'//,
>          'LONG.....LONGEST WAVELENGTH TO BE PASSED'//,
>          'MUST BE LARGER THAN SHORT ...no kidding!'/
c
>          'CUTHI.....HIGHEST WAVENUMBER TO PASSED .LE. NYQUIST'//
c
>          'CUTLO.....LOWEST WAVENUMBER TO BE PASSED .GE. 0.0 AND'//
c
>          '.LT. CUTHI'//
>          'NPASS.....-1 TO REJECT WAVELENGTHS BETWEEN SHORT'//
>          'AND LONG'//
>          '1 TO PASS WAVELENGTHS BETWEEN SHORT AND'//
>          'LONG'//
>          'NOTE : WAVENUMBER = 1/WAVELENGTH AND IS '//
>          'CALCULATED BY THE PROGRAM'//
>          'INPUT ORDER IS DELTA SHORT LONG NPASS')
    read (*,*) delta,short,long,npass
    write (*,9994)
9994 format (' NWIND..... TYPE OF WINDOW TO APPLY'//
>          '0 GIVES NO WINDOW'//
>          '1 RECTANGULAR WINDOW'//
>          '2 BARTLETT WINDOW (TRIANGULAR)'//
>          '3 HAMMING-TUKEY WINDOW'//
>          '4 PARZEN WINDOW'//
>          'XLAG.....SMOOTHING PARAMETER FOR WINDOWING IDEAL'//
>          'FILTER IN SPATIAL DOMAIN (95.0) (is disabled if'//
>          'no window was chosen above)'//
>          'nwind xlag')
    read (*,*) nwind,xlag
    endif
c
    if (lhb .ge. 2 .and. lhb .le. 5 .or. cc .eq. 1) then
        write (*,9995)
9995 format ('WHAT IS THE MINIMUM CORR COEF TO BE PASSED:(0.3)'//,
>          'WHAT IS THE MAXIMUM CORR COEF TO BE PASSED:(1.0)'//,
>          '0 DO NOT CHECK MATCH OF PASSNOS'//,
>          '1 FOR PROGRAM TO CHECK MATCH OF PASSNOS'//,
>          'MINIMUM INPUT CC WITHOUT WRITING WARNING'//,
>          'MAXIMUM INPUT CC WITHOUT WRITING WARNING'//,
>          'CNWIND..... TYPE OF WINDOW TO APPLY'//
>          '0 GIVES NO WINDOW'//

```

```

> '          = 1 RECTANGULAR WINDOW'//
> '          = 2 BARTLETT WINDOW (TRIANGULAR)'//
> '          = 3 HAMMING-TUKEY WINDOW'//
> '          = 4 PARZEN WINDOW'//
> 'CXLAG.....SMOOTHING PARAMETER FOR WINDOWING IDEAL'//
> '          FILTER IN SPATIAL DOMAIN (95.0) (is disabled if'//
> '          no window was chosen above). '//
> 'mincc maxcc match minccin maxccin cwind cxlag')
read (*,*) mincc,maxcc,match,minccin,maxccin,cwind,cxlag
endif
if (numfile .eq. 2) then
write (*,*) 'AND FINALLY: 0 DO NOT SUBTRACT FILE1-FILE1 (use 0)'
write (*,*) '1 TO WRITE A FILE OF TIME DOMAIN SUBTRACTION'
write (*,*) 'OF FILE 3 - INPUT FILE 1 - OUTPUT FILE 1'
read (*,*) isub
c----- isub equals 1 if you want to subtract
c          the filtered portions of file1 from the
c          input of file1. this option is not
c

      often used.
      endif
c
      go to 200
c
100 continue
read (22,*) numfile
read (22,*) lhb,cc
read (22,*) nob, fold, prcnt, imean
read (22,*) delta, short, long, npass
read (22,*) nwind, xlag
read (22,*) mincc, maxcc, match, minccin, maxccin, cwind, cxlag
read (22,*) isub
c
200 continue
c
write (*,*) 'all input files must have a header with:'
write (*,*) 'row,column,zero,mean,pass number,eight'
write (*,*) 'zero... can be bogus but row and col are necessary'
write (*,*) 'INPUT FILE 1 (do not put guide function file here)'
read (*,9990) filename
9990 format (a80)
open (10, file=filename, status='old', form='unformatted')
if (numfile .eq. 2) then
write (*,*) 'INPUT FILE 2 (or the guide function file)'
read (*,9990) filename
open (11, file=filename, status='old', form='unformatted')
endif
write (*,*) 'OUTPUT OF FILE 1'
read (*,9990) filename
open (20, file=filename, form='unformatted')
if (numfile .eq. 2) then
write (*,*) 'OUTPUT OF FILE 2'
read (*,9990) filename
open (21, file=filename, form='unformatted')
endif
write (*,*) 'OUTPUT FILE OF STATISTICS AND INFORMATION'
read (*,9990) filename
open (25, file=filename, form='formatted')
if (isub .eq. 1) then
write (*,*) 'OUTPUT FILE 3 OF SUBTRACTION'
read (*,9990) filename
open (23, file=filename, form='unformatted')
endif
c
if (lhb .lt. 6) then
cuthi=1.0/short
cutlo=1.0/long
RCUTLO=999999.99
IF (CUTLO .GE. 0.000001 ) RCUTLO= 1.0/CUTLO
RCUTHI=1.0/CUTHI
WAVLEN=2.0*DELTA
FNQ1=1.0/WAVLEN
WRITE (25,9987) FNQ1,WAVLEN,CUTLO,RCUTLO,CUTHI,RCUTHI
9987 FORMAT('NYQUIST WAVENUMBER =',F10.5,' CYCLES PER DATA INTERVAL'//,
> 'NYQUIST WAVELENGTH = ',F10.5,' LENGTH INTERVALS'//,
> 'LOW WAVE# CUTOFF OF IDEAL FILTER = ',F10.5,
> ' CYCLES PER DATA INTERVAL ',F15.5,
> ' WAVELENGTH EQUIVALENT'//,
> 'HIGH WAVE# CUTOFF OF IDEAL FILTER = ',F10.5,
> ' CYCLES PER DATA INTERVAL ',F15.5,
> ' WAVELENGTH EQUIVALENT'//)
endif
c
gfcnt=0
210 continue
read (10,end=999) xrow,xcol,zero,xmean,xpassno,eight
xnobs=xrow
do i=1,xrow

```

```

        read (10) xdata(i)
    enddo
230 if (numfile .eq. 2) then
        read (11,end=999) yrow,ycol,zero,ymean,ypassno,seven
        if (seven .eq. 7777) go to 500
        ynobs=yrow
        do i=1,yrow
            read (11) ydata(i)
        enddo
    endif
c
    if (isub .eq. 1) then
        do i=1,xrow
            strxdata(i)=xdata(i)
        enddo
    endif
c
    xmean=0.0
    call forwardft (1,xmean,xpassno)
    ymean=0.0
    if (numfile .eq. 2) call forwardft (2,ymean,ypassno)
c
    if (lhb .le. 3) then
        call filter (1)
        if (numfile .eq. 2) call filter (2)
    endif
c
    if (lhb .ge. 2 .and. lhb .le. 5 .or. cc .eq. 1) then
        call correlate(xpassno,ypassno)
    endif
c
    if (lhb .ge. 3 .and. lhb .le. 5) then
        call filter (1)
        if (numfile .eq. 2) call filter (2)
    endif
c
    if (lhb .eq. 5) call correlate(xpassno,ypassno)
c
    call inverseft (1,xmean,xpassno)
    if (numfile .eq. 2) call inverseft (2,ymean,ypassno)
c
c
500 write (20) xrow,xcol,zero,xmean,xpassno,eight
    do i=1,xrow
        write (20) xdata(i)
    enddo
    if (numfile .eq. 2) then
530 write (21) yrow,ycol,zero,ymean,ypassno,seven
        if (seven .eq. 7777) then
            gfcnt=gfcnt+1
            go to 570
        endif
        do i=1,yrow
            write (21) ydata(i)
        enddo
570 if (isub .eq. 1) then
            if (seven .eq. 7777) then
                write (23) xrow,xcol,zero,xmean,xpassno,eight
                do i=1,xrow
                    write (23) xdata(i)
                enddo
            elseif (seven .ne. 7777) then
                write (23) xrow,xcol,zero,xmean,xpassno,seven
                do i=1,xrow
                    write (23) ( strxdata(i)-xdata(i) )
                enddo
            endif
        endif
    endif
c
    go to 210
c
999 continue
    if (gfcnt .gt. 0)
> write (*,*) 'total passes without a guide function =',gfcnt
        close (10)
        close (11)
        close (20)
        close (21)
        close (22)
        close (25)
        stop
    end
c
c
c
    subroutine forwardft (num,mean,passno)
    integer num,xnobs,ynobs,xynobs,nobs,passno
    real xdata(4096),ydata(4096),prcnt,mean
    complex xcdata(4096),ycdata(4096)

```

```

common /fftifft/ nob,prcnt,lmean,fold
common /rowcol/ xnobs,ynobs
common /reals/ xdata,ydata
common /comps/ xcdata,ycdata
COMMON H(4096)
DIMENSION X(2,4096)
COMPLEX H
double precision TSUM
EQUIVALENCE (X(1,1),H(1))

C
C Tsum=0.D0
C if (num .eq. 1) then
C   xynobs=xnobs
C   do i=1,xynobs
C     x(1,i) = xdata(i)
C     tsum=tsum+x(1,i)
C   enddo
C elseif (num .eq. 2) then
C   xynobs=ynobs
C   do i=1,xynobs
C     x(1,i) = ydata(i)
C     tsum=tsum+x(1,i)
C   enddo
C endif

C
C ----- subroutine description
C
C.....REQUIRED SUBROUTINES :
C
C   FFT1D, FORK, DATWND
C
C.....DIMENSIONING REQUIREMENTS :
C
C   X(2,N).....WHERE N IS THE NUMBER OF COLUMNS AND ROWS OF THE
C   H(N)        OUTPUT TRANSFORMED MATRIX. N MUST BE AN INTEGRAL
C               POWER OF TWO (2,4,8,16...).
C               NOTE : DIMENSIONS IN EVERY SUBROUTINE MUST BE
C               SET EQUAL TO DIMENSIONS IN MAIN PROGRAM.
C
C.....AUTHOR :SUBROUTINES FFT2D AND FORK ARE MODIFIED FROM JON REED,
C   PURDUE UNIVERSITY, DECEMBER 1980.
C   ALL OTHER CODE WRITTEN BY:
C   JEFFREY E. LUCIUS
C   GEOPHYSICAL INTERACTIVE COMPUTING LABORATORY
C   DEPARTMENT OF GEOLOGY AND MINERALOGY
C   THE OHIO STATE UNIVERSITY
C   COLUMBUS, OHIO 43210
C
C   MARCH 25, 1985   (REVISED DEC 5, 1986)
C
C
C   revised once again for DEC workstations on 6 APR 90 so that
C   that this beast is actually user friendly.
C   These revisions will almost always be lower case letters.
C
C   revised again (judas priest this is getting old) on
C   1 AUG 90 into this present format of all fourier programs
C   combined into this program. for a full listing of all
C   comments in the 6 APR 90 version, see that version. no
C   kidding.
C
C*****
C
C   IF (2**INT (ALOG (FLOAT (nob)) /ALOG (2.0) +0.01) .NE.nob) THEN
C     WRITE (6,1030)
C     STOP
C   ENDIF
C
C.....CALCULATE AND REMOVE THE MEAN
C
C   XMEAN1=TSUM/FLOAT(xynobs)
C   DO IY=1,xynobs
C     X(1,IY)=X(1,IY)-XMEAN1
C   enddo
C   WRITE (25,1020) XMEAN1
C
C.....WINDOW THE EDGES VIA DATWND
C
C   CALL DATWND (PRCNT,xynobs,nob,fold)
C
C.....MATRIX IS NOW ZERO FILLED TO NXOUT BY NYOUT SIZE
C   CALCULATE AND REMOVE THE MEAN INTRODUCED BY TAPERING
C
C   Tsum=0.D0
C   DO IY=1,nob
C     Tsum=Tsum+X(1,IY)
C   enddo
C   XMEAN2=TSUM/FLOAT(nob)
C   DO IY=1,nob

```

```

      X(1,IY)=X(1,IY)-XMEAN2
    enddo
c   WRITE(25,1020) XMEAN2
    XMEAN=XMEAN2+XMEAN1
c   WRITE(25,1080) XMEAN
    write (25,*) passno,xmean1,xmean2,xmean
c
c.....TRANSFORM DATA TO THE WAVENUMBER DOMAIN
c
c   CALL FFT1D(nobs,-1)
c
c   mean=xmean
c   if (num .eq. 1) then
c     do ix=1,nobs
c       xcdata(ix) = h(ix)
c     enddo
c   elseif (num .eq. 2) then
c     do ix=1,nobs
c       ycdata(ix) = h(ix)
c     enddo
c   endif
c
c   return
c
1020 FORMAT('MEAN REMOVED ',F15.7)
1030 FORMAT(1H , 'nobs MUST BE A POWER OF 2: SPA2FRQ FATAL')
1080 FORMAT('TOTAL MEAN REMOVED ',F15.7)
c
c   END
c
c*****
c
c   SUBROUTINE FFT1D (nobs,NSIGN)
c
c*****
c   "FFT1D" PERFORMS BOTH A FORWARD OR INVERSE FAST FOURIER
c   TRANSFORM. "FFT1D" IS THE DRIVER THAT PASSES THE CORRECT VECTORS
c   TO "FORK" WHICH PERFORMS THE ACTUAL TRANSFORMING.
c   THE DIMENSIONING OF "H" MUST BE THE SAME AS IN THE MAIN PROGRAM
c
c   "nobs" = NUMBER OF fft observations IN DATA MATRIX
c   "NSIGN" = DIRECTION OF DESIRED TRANSFORMATION
c             +1 INVERSE TRANSFORM (FREQUENCY TO SPATIAL)
c             -1 FORWARD TRANSFORM (SPATIAL TO FREQUENCY)
c*****
c
c   COMMON H(4096)
c   COMPLEX H
c
c   SIGNI=FLOAT(NSIGN)
c   IF (IABS(NSIGN).NE.1) THEN
c     WRITE(6,105)
c     STOP
c   ENDIF
c
c   CALL FORK (nobs,H,SIGNI)
c
c   RETURN
105 FORMAT(5X,'"NSIGN" MUST EQUAL +1 OR -1 FOR "FFT2D", FATAL')
c   END
c*****
c
c   SUBROUTINE FORK (LXX,CX,SIGNI)
c*****
c   FAST FOURIER TRANSFORM, MODIFIED FROM CLAERBOUT, J.F., FUNDAMENTAL
c   OF GEOPHYSICAL DATA PROCESSING, MCGRAW-HILL, 1976
c   FORK USES COOLEY-TUKEY ALGORITHM.
c
c   "CX" = DATA VECTOR TO BE TRANSFORMED
c   "LXX" = LENGTH OF DATA VECTOR "CX" TO BE TRANSFORMED,
c           MUST BE A POWER OF 2 (LXX=2**INTEGER)
c   "SIGNI"= DIRECTION OF DESIRED TRANSFORMATION
c            +1. INVERSE TRANSFORM (FREQUENCY TO SPATIAL)
c            -1. FORWARD TRANSFORM (SPATIAL TO FREQUENCY)
c
c   NORMALIZATION PERFORMED BY DIVIDING BY
c   DATA LENGTH UPON THE FORWARD TRANSFORM.
c*****
c
c   COMPLEX CX(LXX),CW,CTEMP,CON2
c
c   LX=LXX
c   LXH=LX/2
c   J=1
c   DO 103 I=1,LX

```

```

      IF (I.LT.J) THEN
        CTEMP=CX(J)
        CX(J)=CX(I)
        CX(I)=CTEMP
      ENDIF
      M=LX
102    IF (J.GT.M) THEN
        J=J-M
        M=M/2
        IF (M.GE.1) GO TO 102
      ENDIF
      J=J+M
103    CONTINUE
      L=1
104    ISTEP=2*L
      CON2=(0.0,3.14159265)/FLOAT(L)*SIGNI
      DO 105 M=1,L
        CW=CEXP(CON2*FLOAT(M-1))
        DO 105 I=M,LX,ISTEP
          CTEMP=CW*CX(I+L)
          CX(I+L)=CX(I)-CTEMP
105    CX(I)=CX(I)+CTEMP
        L=ISTEP
        IF (L.LT.LX) GO TO 104
        IF (SIGNI.GT.0.0) RETURN
        SC=1./FLOAT(LX)
      C
      DO 106 I=1,LX
106    CX(I)=CX(I)*SC
      C
      RETURN
      END
C
C*****
C
      SUBROUTINE DATWND (PRCNT,xynobs,nobs,fold)
      integer xynobs
C
C*****
C
      "DATWND" MULTIPLIES THE INPUT F(1,xynobs) BY A HALF BELL OF A HAMMIN*
      TUKEY WINDOW ON ALL EDGES AND ZEROS OUT THE REMAINDER OF THE *
      (NX,NY) ARRAY. *
C
C "PRCNT" =PERCENTAGE OF DATA TO BE ALTERED IN SMOOTHING TO ZERO *
      0.0 .LT. "PRCNT" .LE. 50.0 *
C
C
      update 2 feb 91
      c
      datwnd has been considerably improved such that now the subroutine
      c
      performs three (count them, three !!) functions. one; a percentage
      c
      of the input matrix can be folded out. two; after folding out,
      c
      a new percentage of the folded out matrix (or regular data if
      c
      folding was not performed) can be smoothed to zero. three; the
      c
      manipulated data is centered within zeros to finish filling the
      c
      matrix to nx by ny size. because the actual data is now centered
      c
      within the transformed array, it is necessary to use the
      c
      do loops in subroutine inverseft to correctly extract the actual
      c
      data
      c
C*****
C
      dimension holdme(4096)
      COMMON F(2,4096)
C
C----- fold out the data based on percentage
C
      nx1=xynobs
      if (fold.gt.0.0 .and. fold.lt.100.0) then
        KX=Int(fold*FLOAT(xynobs)/100.0+0.5)
        if (kx+xynobs .gt. nobs) kx=(nobs-xynobs)/2
        do i=1,xynobs
          holdme(i)=f(1,i)
        enddo
C----- fold out the observations
      do i=1,xynobs+kx+kx
        if (i.le.kx) f(1,i)=holdme(kx-i+1)
        if (i.gt.kx .and. i.le.(kx+xynobs)) f(1,i)=holdme(i-kx)
        if (i.gt.(kx+xynobs)) f(1,i)=holdme((2*xynobs+kx+1-i))
      enddo
      nx1=xynobs+2*kx
    endif
C
      if (prcnt.gt.0.0 .and. prcnt.lt.50.0) then
C
      KX=IFIX(PRCNT*FLOAT(NX1)/100.0+0.5)
C
      IF (KX.NE.0) THEN
        RKXPI= 3.14159265/FLOAT(KX)
        DO IX=1,KX
          FACTOR=0.5*(1.0+COS(FLOAT(KX-IX+1)*RKXPI))
          IXX=NX1-IX+1
          F(1,IXX)=F(1,IXX)* FACTOR
        DO

```

```

        enddo
      ENDIF
C
C      WRITE(25,150) KX, KY
C      write (25,*) kx,ky
C    endif
C.....center and ZERO OUT REMAINDER OF ARRAY IF NECESSARY
C
      nxhalf=(nobs-nx1)/2
      do i=1,nx1
        holdme(i)=f(1,i)
      enddo
      do i=1,nxhalf
        f(1,i)=0.0
      enddo
      do i=nxhalf+1,nxhalf+nx1
        f(1,i)=holdme(i-nxhalf)
      enddo
      do i=nxhalf+nx1+1,nobs
        f(1,i)=0.0
      enddo
C
      RETURN
150  FORMAT('smoothed',14,' values on both x edges'/,
>    ',14',' y ')
C
      END
C
C
C
      subroutine filter (num)
      integer num,npass,imean,nwind,nobs
      real prcnt,xlag,delta,cuthi,cutlo
      complex xcdat(4096),ycdat(4096),cdat(4096)
      common /rowcol/ xnobs,ynobs
      common /fftifft/ nobs,prcnt,imean,fold
      common /comps/ xcdat,ycdat
      common /lhbflt/ delta,cuthi,cutlo,xlag,npass,nwind
      COMMON H(4096)
      COMPLEX H
      DIMENSION D1(2,4096)
      EQUIVALENCE (D1(1,1),H(1))
C
      if (num .eq. 1) then
        do i=1,nobs
          cdat(i) = xcdat(i)
        enddo
      elseif (num .eq. 2) then
        do i=1,nobs
          cdat(i) = ycdat(i)
        enddo
      endif
C*****
C
C      PROGRAM BANDPASS
C
C      PROGRAM BANDPASS PERFORMS HIGH, LOW, OR BANDPASS WAVENUMBER
C      FILTERING OF UNIFORMLY GRIDDED ARRAYS. AN IDEAL FILTER
C      IS CONSTRUCTED IN THE WAVENUMBER DOMAIN, WINDOWED IN THE SPACE
C      DOMAIN, THEN TRANSFORMED BACK INTO THE WAVENUMBER DOMAIN TO BE
C      MULTIPLIED BY THE INPUT TRANSFORM.
C
C.....REQUIRED SUBROUTINES :
C
C      BNDPAS, FFT2D, FORK, STORE, WINDOW
C
C.....DIMENSIONING REQUIREMENTS :
C
C      D1(2,N).....WHERE N IS THE NUMBER OF observations OF THE
C      H(N)          INPUT AND OUTPUT TRANSFORMED MATRIX. N MUST BE AN
C                   INTEGRAL POWER OF TWO (2,4,8,16...).
C                   NOTE : DIMENSIONS IN EVERY SUBROUTINE MUST BE
C                   SET EQUAL TO DIMENSIONS IN MAIN PROGRAM.
C
C.....AUTHOR : JON REED, PURDUE UNIVERSITY, DECEMBER 1980.
C              REVISIONS BY STEVE MATESKON AND JEFF LUCIUS,
C              OHIO STATE UNIVERSITY, JULY 1984.
C
C
C      this program, like others in the fft series, has been updated
C      to the DEC workstation system and now the program is actually
C      usable to just about anybody! revised 21 apr 90
C
C      well, like the other programs in this package, this has been
C      updated on 4 AUG 90. few comments have been removed - mainly
C      those comments about i/o operations not necessary to this
C      package have been removed.
C

```



```

c      update: 2 feb 90, removed need for cstore array
c
c
c*****
c
c.....CREATE IDEAL CONTINUATION FILTER AND STORE IN ARRAY H
c      CALL BNDPAS (CUTLO,CUTHI,NPASS,DELTA,nobs)
c
c.....CREATE SMOOTHED FILTER
c
c      IF (XLAG.GT.0.0 .AND. XLAG.LE.100.0) THEN
c        IF (NWIND.GT.0.AND.NWIND.LE.4) THEN
c          CALL FFT1D (nobs,1)
c          CALL WINDOW (nobs,XLAG,NWIND)
c          CALL FFT1D (nobs,-1)
c        ENDIF
c      ENDIF
c
c.....WRITE FILTER (WAVENUMBER DOMAIN) ONTO UNIT 30 IF IOFIL = 1
c
c      IF (IOFIL.EQ.1) THEN
c        WRITE (30,*) nobs,IZERO,XMEAN
c        WRITE (30,*) (H(IX),IX=1,nobs)
c      ENDIF
c
c      if (num .eq. 1) then
c        do i=1,nobs
c          xcdata(i) = cdata(i)*h(i)
c        enddo
c      elseif (num .eq. 2) then
c        do i=1,nobs
c          ycdata(i) = cdata(i)*h(i)
c        enddo
c      endif
c
c      return
c      end
c
c*****
c
c      SUBROUTINE BNDPAS (CCUTLO,CCUTHI,NPASS,DELTA,nobs)
c*****
c
c      "BNDPAS" CALCULATES THE WAVE# RESPONSE OF AN IDEAL BANDPASS
c      FILTER OF A (nobs) MATRIX.  ARRAY "H" MUST BE DIMENSIONED THE
c      SAME AS IN THE MAIN PROGRAM
c
c      "CCUTLO"  LOWEST WAVE# TO BE PASSED, GE 0.0
c      "CCUTHI"  HIGHEST WAVE# TO BE PASSED, LE NYQUIST
c      "NPASS"   SWITCHES EITHER A PASS OR REJECTION BETWEEN
c               "CUTLO" & "CUTHI"
c               --1 REJECT WAVENUMBERS BETWEEN THE 2 WAVENUMBERS
c               = 1 PASS  WAVENUMBERS BETWEEN THE 2 WAVENUMBERS
c      "DELTA"   DATA GRID INTERVAL, IN MAP UNITS
c      nobs      number of fft observations
c*****
c
c      COMMON H(4096)
c      COMPLEX H,ZERO,ONE
c
c      CUTHI=CCUTHI
c      CUTLO=CCUTLO
c      RCUTLO=999999.99
c      IF (CUTLO.GE. 0.0000001 ) RCUTLO= 1.0/CUTLO
c      RCUTHI=1.0/CUTHI
c      WAVLEN=2.0*DELTA
c      FNQ1=1.0/WAVLEN
c      WRITE (25,112) FNQ1,WAVLEN,CUTLO,RCUTLO,CUTHI,RCUTHI,NPASS
c
c      IF (IABS(NPASS).NE.1) THEN
c        WRITE (6,151)
c        STOP
c      ENDIF
c      IF (CUTHI.GT.FNQ1.OR.CUTHI.LE.CUTLO.OR.CUTLO.LT.0.0) THEN
c        WRITE (6,151)
c        STOP
c      ENDIF
c
c      NXX=nobs+2
c      NX2=(nobs/2)+1
c      ZERO = (0.0,0.0)
c      ONE  = (1.0,0.0)
c      IF (NPASS.NE.1) THEN
c        ZERO = (1.0,0.0)
c        ONE  = (0.0,0.0)
c      ENDIF
c

```

```

      CLOWX=FLOAT(NX2)*WAVLEN*CUTLO
      CHIX =FLOAT(NX2)*WAVLEN*CUTHI
C....."ZERO" OUT THE entire ARRAY
C
      DO IX=1,nobs
        H(IX) = ZERO
      enddo
C
C.....OPERATE ON ROWS WHERE WAVENUMBERS ARE .LE. CUTLO
C
      MINS=1
      MAXS=NX2
      IF(CUTLO.GT.0.000001) MINS= int(clowx + 2.0001)
      IF(FNQ1-CUTHI.GT.0.000001) MAXS=int(chix + 1.0001)
      if (mins .le. maxs) then
        DO IX=MINS,MAXS
          H(NXX-IX)= ONE
          H(IX)= ONE
        enddo
      endif
C
      RETURN
C
112  FORMAT(/1X,'NYQUIST WAVENUMBER =',F10.5,'CYCLES PER DATA INTERVAL'
> /1X,'NYQUIST WAVELENGTH = ',F10.5,' LENGTH INTERVALS'/
> 1X,'LOW WAVE# CUTOFF OF IDEAL FILTER = ',F10.5,
> ' CYCLES PER DATA INTERVAL',3X,F15.5,' WAVELENGTH EQUIVALENT'/
> 1X,'HIGH WAVE# CUTOFF OF IDEAL FILTER = ',F10.5,
> ' CYCLES PER DATA INTERVAL',3X,F15.5,
> ' WAVELENGTH EQUIVALENT',/1X,'NPASS= ',I1//)
151  FORMAT(5X,'IMPOSSIBLE FILTER CONSTRUCTION IS SPECIFIED. FATAL')
C
      END
C
C
C*****
C
      SUBROUTINE WINDOW (nobs,XLAG,NWIND)
C*****
C "WINDOW" PERFORMS 1-DIMENSION WINDOWING OVER the DATA ARRAY
C EACH QUAD. IS SEPERATELY WINDOWED. THE 1.0 COEFFICIENT IS ALWAYS
C THE OUTER MOST CORNER OF THE ARRAY.
C
C "nobs" = NUMBER OF observations IN DATA MATRIX
C "XLAG" = SMOOTHING PARAMETER FOR WINDOWING IDEAL FILTER IN SPATIAL *
C          DOMAIN. DETERMINES WHAT PERCENTAGE OF DATA IS WINDOWED *
C          (nobs*XLAG/100.0) THE REMAINDER IS SET TO 0.0. I.E. THE
C          SMALLER "XLAG" THE SMOOTHER THE WINDOWING.
C          "XLAG" MUST BE .GT. 0.0 .AND. .LE. 100.0 FOR WINDOWING
C          VALUES OUTSIDE OF THIS RESULTS IN NO WINDOWING
C          THE SMALLER THE "XLAG" THE SMOOTHER THE FILTER.
C
C "NWIND" = TYPE OF WINDOW TO APPLY
C          -0 GIVES NO WINDOW
C          -1 gives a rectangular window
C          -2 GIVES BARTLETT WINDOW (TRIANGLE WINDOW)
C          -3 GIVES HAMMING-TUKEY WINDOW
C          -4 GIVES PARZEN WINDOW
C*****
C
      COMMON H(4096)
      COMPLEX H
C
      LAG=FLOAT(nobs)*XLAG/200.0+0.5
      LAG=AMAX0(LAG,2)
      PI=3.14159265
      NXX=nobs+2
      NX2=(nobs/2)+1
      XNXR=FLOAT(NX2)
      XNX=1.0/FLOAT(NX2)
C
      RADIUS=FLOAT(LAG)*XNX
      RADI=1.0/RADIUS
      RAD2= RADIUS*RADIUS
C
C.....APPLY RECTANGULAR WINDOW TO FILTER
C
      IF (NWIND.EQ.1) THEN
        MAX=int(RADIUS*XNXR+1.0001)
        LL=MAX+1
        DO II=LL,NX2
          H(NXX-II)=(0.0,0.0)
          H(II)= (0.0,0.0)
        enddo
C
        WRITE (25,660) XLAG,LAG
        RETURN
C

```

```

C.....APPLY BARTLETT WINDOW TO FILTER
C
    ELSEIF (NWIND.EQ.2) THEN
        MAX=RADIUS*XNKR+1.0001
        IF (MAX.GE.2) THEN
            DO 253 LL=2,MAX
                XI=FLOAT(LL-1)*XNX
                FACTOR=1.0-XI*RADI
                H(LL)=H(LL)*FACTOR
                MX=NX-LL
253         H(MX)=H(MX)*FACTOR
            ENDIF
        C
            LL=MAX+1
            DO 255 II=LL,NX2
                H(NXX-II)=(0.0,0.0)
255         H(II)=(0.0,0.0)
        C
        C
            WRITE(25,661) XLAG,LAG
            RETURN
        C
C.....APPLY HAMMING-TUKEY WINDOW TO FILTER
C
    ELSEIF (NWIND.EQ.3) THEN
        PIRADI=PI*RADI
        MAX=RADIUS*XNKR+1.0001
        IF (MAX.GE.2) THEN
            DO 353 LL=2,MAX
                XI=FLOAT(LL-1)*XNX
                FACTOR=0.5*(1.0+COS(PIRADI*XI))
                H(LL)=H(LL)*FACTOR
                MX=NX-LL
353         H(MX)=H(MX)*FACTOR
            ENDIF
        C
            LL=MAX+1
            DO 355 II=LL,NX2
                H(NXX-II)=(0.0,0.0)
355         H(II)=(0.0,0.0)
        C
        C
            WRITE(25,662) XLAG,LAG
            RETURN
        C
C.....APPLY PARZEN WINDOW TO FILTER
C
    ELSEIF (NWIND.EQ.4) THEN
        MAX=RADIUS*XNKR+1.0001
        MAX2=SQRT(RAD2/4.0)*XNKR+1.0001
        FACTOR=1.0-6.0*((XI*RADI)**2-(XI*RADI)**3)
        H(1)=H(1)*FACTOR
        C
        IF (MAX2.GE.2) THEN
            DO 453 LL=2,MAX2
                XI=FLOAT(LL-1)*XNX
                FACTOR=1.0-6.0*((XI*RADI)**2-(XI*RADI)**3)
                H(LL)=H(LL)*FACTOR
                MX=NX-LL
453         H(MX)=H(MX)*FACTOR
            ENDIF
        C
            KOUNT=MAX2+1
            DO 457 LL=KOUNT,MAX
                XI=FLOAT(LL-1)*XNX
                FACTOR=2.0*(1.0-(XI*RADI)**3)
                H(LL)=H(LL)*FACTOR
                MX=NX-LL
457         H(MX)=H(MX)*FACTOR
            LL=MAX+1
            DO 455 II=LL,NX2
                H(NXX-II)=(0.0,0.0)
455         H(II)=(0.0,0.0)
        C
        C
            WRITE(25,663) XLAG,LAG
            RETURN
        C
C.....DO NOT APPLY A WINDOW TO FILTER
C
    ELSEIF (NWIND.EQ.0) THEN
        C
        WRITE(25,664)
        ENDIF
        C
        RETURN
        C
660 FORMAT ('RECTANGULAR WINDOW USED XLAG= ',F7.3,4X,'LAG= ',I5)
661 FORMAT ('BARTLETT WINDOW USED XLAG= ',F7.3,4X,'LAG= ',I5)
662 FORMAT ('HAMMING-TUKEY WINDOW USED XLAG= ',F7.3,4X,'LAG= ',I5)
663 FORMAT ('PARZEN WINDOW USED XLAG= ',F7.3,4X,'LAG= ',I5)
664 FORMAT ('NO WINDOWING HAS BEEN APPLIED ; XLAG= ',F7.3)
        C
        END

```

```

C
C
      subroutine correlate(xpassno,ypassno)
      integer knobs,ynobs,nobs,match,xpassno,ypassno,
>      zerocnt(4096),cnwind
      real mincc,maxcc,ccwinout,prcnt,
>      pctpr3,pctpr4,minccin,maxccin,cxlag
      complex h(4096),power5,power6,totpwr
      COMPLEX X(4096),Y(4096),zero,
>      POWER1,POWER2,POWER3,POWER4,XPOWER,TPOWER
      REAL CCOEF,CCIN,CCOUT
      DATA ZERO/(0.000000,0.000000)/
      common /rowcol/ knobs,ynobs
      common /comps/ x,y
      common /ccflt/ mincc,maxcc,match,minccin,maxccin,cnwind,cxlag
      common /fftifft/ nobs,prcnt,lmean,fold
      common h

C
C----- subroutine description
C
      correlate finds the correlation coefficient between each
      wavenumber component of the two input arrays. each cc is
      normalized to range between -1.0 through 0.0 to 1.0. the
      cc is the cosine of the phase angle difference between two
      wavenumber components.

C
      revisions:

C
      well, by now you know the story... revised 4 AUG 90
      i've added the windowing functions available from the
      bandpassing subroutines to this cc-filter. try them if
      you like!

C
      updates 1 feb 91: change calculation of correlation
      coefficient from a summation based formula to the cosine of
      the phase angle difference.

C
      if (match .eq. 1) then
        if (xpassno .ne. ypassno) then
          write (*,*) 'NO MATCH BETWEEN PASS NUMBERS',xpassno,ypassno
        endif
      endif
      if (knobs .ne. ynobs ) then
        write (*,*) 'NO MATCH BETWEEN NUMBER OF OBSERVATIONS'
        write (*,*) 'CORRELATION COEF MAY NOT BE CORRECT'
        write (*,*) 'PASSNUMBERS=',xpassno,ypassno
        write (*,*) 'FILE 1: OBSERVATIONS =',knobs
        write (*,*) 'FILE 2: OBSERVATIONS =',ynobs
      endif

C
      pi=3.141592654
      twopi=6.283185307
      POWER1=ZERO
      POWER2=ZERO
      POWER3=ZERO
      POWER4=ZERO
      XPOWER=ZERO
      TPOWER=ZERO

C
      DO 110 i=1,nobs
C----- zerocnt array is a flagging array used to
      set the windowing array h to equal
      (0.0,0.0) or (1.0,0.0). a little inspection
      of subroutine BNDPAS will help illuminate
      the principle.
      zerocnt(i)=1

C
      SUM THE POWERS & CROSS PRODUCTS OF THE INPUT MAPS.
C
      POWER1=POWER1+(X(I)*CONJG(X(I)))
      POWER2=POWER2+(Y(I)*CONJG(Y(I)))
      XPOWER=XPOWER+(X(I)*CONJG(Y(I)))

C
C----- xrad is the phase angle of the x array wavenumber and
      yrad is the phase angle of the y array wavenumber. the
      cosine of the minimum phase difference is the correlation
      of the two wavenumbers. to find the minimum phase difference
      it is necessary to adjust xrad or yrad with integer values
      of pi. so....do not change the order of the if statements !!
C
      xrad=atan(aimag(x(i))/(real(x(i))))
      if (real(x(i)).lt.0.0) xrad=xrad+pi
      if (aimag(x(i)).lt.0.0) xrad=xrad+twopi
      yrad=atan(aimag(y(i))/(real(y(i))))
      if (real(y(i)).lt.0.0) yrad=yrad+pi
      if (aimag(y(i)).lt.0.0) yrad=yrad+twopi
      delrad=abs(xrad-yrad)
      ccoef=cos(delrad)
C

```

```

      IF (CCOEF .GT. maxcc .or. CCOEF .LT. mincc) THEN
        X(I)=ZERO
        Y(I)=ZERO
        zerocnt(I)=0
      ENDIF
C
C SUM THE POWERS & CROSS PRODUCTS FOR THE OUTPUT MAPS.
C
      POWER3=POWER3+(X(I)*CONJG(X(I)))
      POWER4=POWER4+(Y(I)*CONJG(Y(I)))
      TPPOWER=TPPOWER+(X(I)*CONJG(Y(I)))
110 CONTINUE
C
C CALCULATE THE C.C. FOR THE INPUT MAPS.
C
      if (power1 .eq. zero .or. power2 .eq. zero) then
        write (*,*) 'power1 =',power1,xpassno
        write (*,*) 'power2 =',power2,ypassno
        ccin=9999.9
      else
        CCIN=REAL(XPOWER/SQRT(POWER1*POWER2))
      endif
C
C CALCULATE THE C.C. FOR THE OUTPUT MAPS.
C
      if (power3 .eq. zero .or. power4 .eq. zero) then
        write (*,*) 'power3 =',power3,xpassno
        write (*,*) 'power4 =',power4,ypassno
        ccout=9999.9
      else
        CCOUT=REAL(TPOWER/SQRT(POWER3*POWER4))
      endif
C
C CALCULATE THE PERCENTAGE OF THE POWER RETAINED IN THE FILTERED
C MAPS.
C
      if (power1 .eq. zero .or. power2 .eq. zero) then
        pctpr1=9999.9
        pctpr2=9999.9
      else
        PCTPR1=(POWER3/POWER1)*100.0
        PCTPR2=(POWER4/POWER2)*100.0
      endif
C
C WRITE THE C.C. FOR THE INPUT & OUTPUT MAPS TO FILE 6.
C
C      WRITE (6,444) CCIN
C      WRITE (6,555) CCOUT
C
C WRITE THE POWER PERCENTAGES TO FILE 6.
C
C      WRITE (6,666) PCTPR1,PCTPR2
C 444 FORMAT (' ', 'THE CORRELATION COEFFICIENT BETWEEN THE INPUT '
C          * , 'MAPS IS ',F6.3)
C 555 FORMAT (' ', 'THE CORRELATION COEFFICIENT BETWEEN THE OUTPUT '
C          * , 'MAPS IS ',F6.3)
C 666 FORMAT (' ', 'THE PERCENTAGE OF THE TOTAL POWER IN MAP ONE',
C          * ' PASSED IS',F7.3,'% ', ' THE PERCENTAGE OF THE TOTAL POWER',
C          * ' IN MAP TWO PASSED IS',F7.3,'% ')
C
C      write (25,888) xpassno,ypassno,ccin,ccout,pctpr1,pctpr2
C 888 format (2i6,4f10.3)
C      if (ccin .lt. minccin) write (*,*)xpassno,ypassno,ccin,' <min'
C      if (ccin .gt. maxccin) write (*,*)xpassno,ypassno,ccin,' >max'
C
C----- the following if statement controls
C          the windowing functions for smoothing
C          the output arrays and calculates a new
C          output correlation coefficient and
C          percents of power retained in the
C          windowed arrays because
C          the data will change slightly with
C          windowing
C
      if (cnwind .ge. 1 .and. cnwind .le. 4) then
        power5=zero
        power6=zero
        totpr=zero
        do i=1,nobs
          h(i)=(1.0,0.0)
          if (zerocnt(i) .eq. 0) h(i) = (0.0,0.0)
        enddo
        call fftld (nobs,1)
        call window (nobs,cxlag,cnwind)
        call fftld (nobs,-1)
        do i=1,nobs
          x(i) = x(i)*h(i)
          y(i) = y(i)*h(i)
          power5=power5+(x(i)*conjug(x(i)))

```

```

        power6=power6+(y(i)*conjg(y(i)))
        totpwr=totpwr+(x(i)*conjg(y(i)))
    enddo
    if (power5 .eq. zero .or. power6 .eq. zero) then
        write (*,*) 'power5 =',power5,xpassno
        write (*,*) 'power6 =',power6,ypassno
        ccwinout=9999.9
        go to 340
    endif
    if (power1 .eq. zero .or. power2 .eq. zero) then
        pctpr3=9999.9
        pctpr4=9999.9
        go to 340
    endif
    ccwinout=real(totpwr/sqrt(power5*power6))
    pctpr3=(power5/power1)*100.0
    pctpr4=(power6/power2)*100.0
340    continue
    write (25,888) xpassno,ypassno,ccin,ccwinout,pctpr3,pctpr4
c 888    format (2i6,4f10.3)
    endif
c
    return
end
c
c
c
c
    subroutine inverseft (num,mean,passno)
    integer num,xnobs,ynobs,xynobs,row,col,passno
    real xdata(4096),ydata(4096),mean
    complex xcddata(4096),ycddata(4096)
    common /rowcol/ xnobs,ynobs
    common /reals/ xdata,ydata
    common /comps/ xcddata,ycddata
    common /fftifft/ nobs,prcnt,imean,fold
    common H(4096)
    DIMENSION X(2,4096),holdme(4096)
    COMPLEX H
    EQUIVALENCE (X(1,1),H(1))
c
    if (num .eq. 1) then
        xynobs=xnobs
        do i=1,nobs
            h(i) = xcddata(i)
        enddo
    elseif (num .eq. 2) then
        xynobs=ynobs
        do i=1,nobs
            h(i) = ycddata(i)
        enddo
    endif
c
c-----subroutine description
c.....REQUIRED SUBROUTINES :
c
c      FFT1D, FORK
c
c.....DIMENSIONING REQUIREMENTS :
c
c      X(2,N).....WHERE N IS THE NUMBER OF COLUMNS AND ROWS OF THE
c      H(N)        OUTPUT TRANSFORMED MATRIX. N MUST BE AN INTEGRAL
c                  POWER OF TWO (2,4,8,256...).
c      NOTE : DIMENSIONS IN EVERY SUBROUTINE MUST BE
c      SET EQUAL TO DIMENSIONS IN MAIN PROGRAM.
c
c.....AUTHOR : JEFF LUCIUS
c              DEPARTMENT OF GEOLOGY AND MINERALOGY
c              OHIO STATE UNIVERSITY, DECEMBER 1984.
c
c      revised: 8 AUG 90
c      updated: 2 feb 91
c              added do loops that find the data portion of the
c              zero centered inverse transformed data. a look at
c              subroutine datwnd will help figure this out.
c
c.....INVERSE TRANSFORM DATA TO THE SPACE DOMAIN
c
c      CALL FFT1D (nobs,+1)
c
c      nxhalf=(nobs-xynobs)/2
c      do i=nxhalf+1,nxhalf+xynobs
c          holdme(i-nxhalf)=x(1,i)
c      enddo
c
c      total=0.0
c      DO I=1,xynobs
c          x(1,i)=holdme(i)
c          total=total+x(1,i)
c      enddo
c      xmean=total/float(xynobs)

```

```

      IF (IMEAN .EQ. 1) THEN
        do i=1,xynobs
          x(1,i)=x(1,i)+mean
        enddo
      ENDIF
C
      XMIN= 1.0E20
      XMAX=-1.0E20
      if (num .eq. 1) then
        do i=1,xynobs
          xdata(i) = x(1,i)
        enddo
      elseif (num .eq. 2) then
        do i=1,xynobs
          ydata(i) = x(1,i)
        enddo
      endif
      DO I=1,xynobs
        XMIN=AMIN1 (XMIN,X(1,I))
        XMAX=AMAX1 (XMAX,X(1,I))
        IF (XMAX.EQ.X(1,I)) IMAX=I
        IF (XMIN.EQ.X(1,I)) IMIN=I
      enddo
C
      WRITE(25,1020) XMAX,IMAX,XMIN,IMIN,xmean,passno
      write (25,9980) passno,xmean,xmax,imax,xmin,imin
9980 format (i5,2x,f13.5,2x,f13.5,2x,i4,f13.5,2x,i4)
C
1020 FORMAT('MAXIMUM OF IFFT = ',E15.7,' AT (',I3,')'//,
>         'MINIMUM = ',E15.7,' AT (',I3,')'//,
>         'MEAN AFTER IFFT = ',E15.7,' FOR PASS',i6,/)
C
      return
      END

```





```

program combine
integer xrow,xcol,zero,eight,xpassno,ypassno,ycol,
> x3row,x3col,x3pass,y3row,y3col,y3pass,yrow,
> strcnt,syrow,sy3row,sycol,sy3col,nobs,noc,
> syypassno,sy3pass,dndk,tcount,paircnt,minobs,
> paircntl,choice,totobs,prime,global,crosscnt,
> passrem,nowant(4000),nocnt,type
real xmean,ymean,x3data(400,3),y3data(400,3),y3mean,
> xldata(400),yldata(400),xadata(400,4),ybdata(400,4),
> x3mean,sy3mean,symean,x(400),y(400),
> saveyl(400),savey3(400,3),xamean,
> ybmean,avgdata(400,4)
character*80 filename
common /trunstat/ xadata(400,4),ybdata(400,4)
common x3data(400,3),xldata(400),y3data(400,3),yldata(400)
common /aver/ avgdata(400,4)
common /tplot/ x(400),y(400)
common /nope/ nowant(4000),nocnt

c
c----- program description
c
c combine is very similar to movetrunc in that both
c programs truncate adjacent passes to the same over-
c lapping segments. both programs also provide
c statistics and track output files. the major
c difference is that movetrunc has only one file
c as input whereas combine has two files as input.
c combine can output one file of two passes averaged
c together to make the one file or it can output
c two similar length passes that can be further
c processed by fourier methods. movetrunc and combine
c could be cluged together to make one program
c so why don't you go ahead and jam them together??
c good luck!!
c
c program date: 16 apr 91
c
c write (*,*) '1 TO HAVE ONE OUTPUT FILE'
c write (*,*) '2 TO HAVE TWO OUTPUT FILES'
c read (*,*) ifilenum
c if (ifilenum .eq. 2) then
c prime=1
c goto 3
c endif
c write (*,*) '1 TO AVERAGE A-east AND A-west'
c write (*,*) '2 TO AVERAGE A-east AND B-west (choose 2)'
c read (*,*) prime
3 write (*,*) '0 IF THE DATA SET IS GLOBAL OR POLAR'
c write (*,*) '1 IF THE DATA SET DOES NOT INCLUDE ALL LONGITUDES'
c read (*,*) global
c
c if (prime .eq. 1) then
c write (*,*) 'NOTE: FILE Y WILL HAVE THE FIRST PASS MOVED'
c write (*,*) 'TO THE BOTTOM OF THE FILE'
c write (*,*) ' '
c if (global .eq. 1) then
c write (*,*) 'AND THE FIRST PASS WILL NOT BE INCLUDED IN'
c write (*,*) 'THE PROCESSING. FILE X WILL HAVE THE LAST'
c write (*,*) 'PASS REMOVED AND THIS PASS WILL NOT BE INCLUDED'
c write (*,*) 'IN THE PROCESSING'
c endif
c endif
c
c write (*,*) 'INPUT FILE X OF LAT-LONG-RAD DATA'
c read (*,9990) filename
9990 format(a80)
c open (10, file=filename,status='old',form='unformatted')
c write (*,*) 'INPUT FILE X OF MAGNETIC VARIABLES'
c read (*,9990) filename
c open (11, file=filename,status='old',form='unformatted')
c write (*,*) 'INPUT FILE Y OF LAT-LONG-RAD DATA'
c read (*,9990) filename
c open (12, file=filename,status='old',form='unformatted')
c write (*,*) 'INPUT FILE Y OF MAGNETIC VARIABLES'
c read (*,9990) filename
c open (13, file=filename,status='old',form='unformatted')
c
c if (ifilenum .eq. 1) then
c write (*,*) 'OUTPUT FILE OF TRUNCATED LAT-LONG-RAD-ANOM DATA'
c write (*,*) 'AND -----NO HEADERS TO BE WRITTEN-----'
c read (*,9990) filename
c open (20, file=filename,form='formatted')
c write (*,*) 'OUTPUT FILE OF LAT-LON TO BE RUN IN TPLLOT'
c read (*,9990) filename
c open (21, file=filename,form='unformatted')
c
c
c elseif (ifilenum .eq. 2) then
c write (*,*) 'OUTPUT FILE X OF LAT-LON-RAD'
c read (*,9990) filename
c open (30, file=filename, form='unformatted')

```

```

write (*,*) 'OUTPUT FILE X OF VARIABLE'
read (*,9990) filename
open (31, file=filename, form='unformatted')
write (*,*) 'OUTPUT FILE Y OF LAT-LON-RAD'
read (*,9990) filename
open (32, file=filename, form='unformatted')
write (*,*) 'OUTPUT FILE Y OF VARIABLE'
read (*,9990) filename
open (33, file=filename, form='unformatted')
endif

c
write (*,*) 'OUTPUT FILE OF STATISTICS'
read (*,9990) filename
open (25, file=filename, form='formatted')

c
write (*,*) '0 IF THESE ARE DUSK DATA SETS'
write (*,*) '1 IF THESE ARE DAWN DATA SETS'
read (*,*) dndk
if (ifilenum .eq. 1) then
write (*,*) '0 DO NOT REMOVE THE MEAN FROM THE AVERAGED DATASET'
write (*,*) '1 REMOVE THE MEAN'
read (*,*) choice
endif
write (*,*) '0 IF ALL PASSES ARE WANTED'
write (*,*) '1 TO REMOVE THE PASSES THAT ARE NOT WANTED'
read (*,*) nocnt
if (nocnt .eq. 1) then
write (*,*) 'INPUT FILE OF PASSES NOT WANTED'
read (*,9990) filename
open (14, file=filename, form='formatted', status='old')
do 5 i=1,4000
read (14,*,end=6) nowant(i)
5
continue
6
continue
nocnt=i-1
endif
if (prime .eq. 1) then
write (*,*) '1 FOR A LATITUDE GAP FINDER'
write (*,*) '2 FOR A MINIMUM OBSERVATION GAP FINDER'
read (*,*) type
endif
write (*,*) 'AND FINALLY! MINIMUM NUMBER OBSERVATIONS PER PASS'
read (*,*) minobs

c
if (prime .eq. 1) then
write (*,*) '-----'
write (*,*) 'running through dataset to find passes that',
> 'do not overlap'
c----- findgap locates adjacent
c passes that do not overlap
call findgap (global,dndk,minobs,type)
write (*,*) 'done with run through'
write (*,*) '-----'
endif

c
write (25,*) 'XPASS YPASS CCD CCY XVAR YVAR ',
> ' COVARXY XSTDEV YSTDEV'
write (25,*) ' XMEAN YMEAN XSLOPE YSLOPE',
> ' XINTCPT YINTCPT'

c
paircnt=0
paircnt1=0
tcount=0
strcnt=0
totobs=0
noc=0
crosscnt=0
passrem=0

c
10 continue
read (10,end=999) x3row,x3col,zero,x3mean,x3pass,eight
do 15 i=1,x3row
read (10) (x3data(i,ii),ii=1,x3col)
15 continue
read (11) xrow,xcol,zero,xmean,xpassno,eight
do 25 i=1,xrow
read (11) x1data(i)
25 continue
30 continue
read (12,end=150) y3row,y3col,zero,y3mean,y3pass,eight
do 35 i=1,y3row
read (12) (y3data(i,ii),ii=1,y3col)
35 continue
read (13) yrow,ycol,zero,ymean,ypassno,eight
do 45 i=1,yrow
read (13) y1data(i)
45 continue

c
strcnt=strcnt+1
c----- this if statement offsets the passes

```

```

c          and saves the offset for the end
if (strcnt .eq. 1 .and. prime .eq. 1) then
  do 50 i=1,y3row
    do 55 ii=1,y3col
      savey3(i,ii)=y3data(i,ii)
55      continue
      savey1(i)=y1data(i)
50      continue
      sy3row=y3row
      syrow=yrow
      sy3col=y3col
      sycol=ycol
      sy3mean=y3mean
      symean=ymean
      sy3pass=y3pass
      sypassno=ypassno
      go to 30
    endif
c
c    go to 190
c
150 continue
  if (global .eq. 1) go to 999
  do 160 i=1,sy3row
    do 165 ii=1,sy3col
      y3data(i,ii)=savey3(i,ii)
165      continue
      y1data(i)=savey1(i)
160      continue
      y3row=sy3row
      yrow=syrow
      y3col=sy3col
      ycol=sycol
      y3mean=sy3mean
      ymean=symean
      y3pass=sy3pass
      ypassno=sypassno
c
c 190 continue
c
  if (xrow.ne.x3row .or. xpassno.ne.x3pass .or.
>   yrow.ne.y3row .or. ypassno.ne.y3pass) then
    write (*,*) 'WACKO, TRA-LA-LA, JOLLY-GOOD, NO MATCH BETWEEN'
    write (*,*) 'ROWS OR PASSNOS X= ',xrow,x3row,xpassno,x3pass
    write (*,*) ' Y= ',yrow,y3row,ypassno,y3pass
    go to 999
  elseif (xrow.lt.minobs .or. yrow.lt.minobs) then
    write (*,*) 'FILE X PASS',xpassno,' REMOVED: OBSERVATIONS=',xrow
    write (*,*) 'FILE Y PASS',ypassno,' REMOVED: OBSERVATIONS=',yrow
    passrem=passrem+1
    go to 10
  endif
  do 195 i=1,nocnt
    if (nowant(i).eq.xpassno .or. nowant(i).eq.ypassno) then
      write (*,*) 'FILE X PASS',xpassno,' REMOVED NOT WANTED'
      write (*,*) 'FILE Y PASS',ypassno,' REMOVED NOT WANTED'
      passrem=passrem+1
      go to 10
    endif
195 continue
c
c    call truncate (xrow,yrow,dndk,nobs,pairent1,minobs)
c
c    call statistics (nobs,xpassno,ypassno,xamean,ybmean)
c
c    if (ifilenum .eq. 1) call average (nobs,choice,prime,crosscnt)
c
c    if (ifilenum .eq. 2) then
      if (xpassno .ne. ypassno) then
        write (*,*) xpassno,ypassno,' no match pass numbers'
        stop 444
      endif
      ithree=3
      ione=1
      xxavg=0.0
      ieight=8888
      izero=0
      write (30) nobs,ithree,zero,xxavg,xpassno,ieight
      write (31) nobs,ione,zero,xxavg,xpassno,ieight
      write (32) nobs,ithree,zero,xxavg,ypassno,ieight
      write (33) nobs,ione,zero,xxavg,ypassno,ieight
      do j=1,nobs
        if (xadata(j,3) .gt. 180.0) xadata(j,3)=xadata(j,3)-360.0
        write (30) xadata(j,1), (xadata(j,1),i=3,4)
        write (31) xadata(j,2)
        if (yadata(j,3) .gt. 180.0) yadata(j,3)=yadata(j,3)-360.0
        write (32) yadata(j,1), (yadata(j,1),i=3,4)
        write (33) yadata(j,2)
      enddo
      go to 300
    endif

```

```

endif
c
c-----write out the truncated lengths passes
c
    if (prime .eq. 1) then
        do 200 j=1,nobs
            if (xadata(j,3) .gt. 180.0) xadata(j,3)=xadata(j,3)-360.0
            write (20,*) xadata(j,1), (xadata(j,i),i=3,4),avgdata(j,4)
200        continue
            do 205 j=1,nobs-1
                if (xadata(j,3) .lt. xadata(j+1,3)) then
                    crosscnt=crosscnt+1
                    go to 207
                endif
            continue
205        continue
207        continue
        elseif (prime .eq. 2) then
            do 220 j=1,nobs
                if (avgdata(j,2).gt.180.0) avgdata(j,2)=avgdata(j,2)-360.0
                write (20,*) (avgdata(j,k),k=1,4)
220            continue
        endif
c
c----- write out the trace of the pass for plotting
c
c
        call track (nobs,noc,prime)
        WRITE (21) NOC,NObs, (X(J),Y(J),J=1,NObs)
c
300    continue
        if (paircnt1 .gt. 0) tcount=tcount+1
        paircnt=paircnt+paircnt1
        totobs=totobs+nobs
c
        go to 10
c
999    continue
        write (*,*) 'corrected',paircnt,' pairs of latitudes in'
        write (*,*) tcount,' passes to beginning lengths'
        write (*,*) 'total passes read = ',strcnt
        write (*,*) 'removed',passrem,' passes from the file'
        write (*,*) 'total observations in the written dataset =',totobs
        write (*,*) 'study area includes',crosscnt,' pairs of',
>        ' longitudes that cross -180.0 180.0'
        close (10)
        close (11)
        close (12)
        close (13)
        close (20)
        close (21)
        close (25)
        close (30)
        close (31)
        close (32)
        close (33)
        stop
        end
c
c
c
c
        subroutine truncate (xrow,yrow,dndk,minrow,stocount,minobs)
        integer xrow,yrow,stocount,rowii,rowinc,minrow,
>        dndk,minobs
        real xdata(400,4),ydata(400,4),
>        x3data(400,3),xldata(400),y3data(400,3),yldata(400),
>        adata,bdata,diffab,abss,xadata(400,4),ybddata(400,4)
        common /trunstat/ xadata(400,4),ybddata(400,4)
        common x3data(400,3),xldata(400),y3data(400,3),yldata(400)
c
c----- subroutine description
c
c        truncate locates the overlapping segment between two
c        adjacent passes and stores that segment in the
c        appropriate arrays
c
        do 70 j=1,xrow
            xdata(j,1)=x3data(j,1)
            xdata(j,2)=xldata(j)
            xdata(j,3)=x3data(j,2)
            xdata(j,4)=x3data(j,3)
70        continue
            do 75 j=1,yrow
                ydata(j,1)=y3data(j,1)
                ydata(j,2)=yldata(j)
                ydata(j,3)=y3data(j,2)
                ydata(j,4)=y3data(j,3)
75        continue
c
80        continue
        stocount=0
        jj=1
        rowii=xrow

```



```

xsum=0.0
xsumsq=0.0
ysum=0.0
ysumsq=0.0
sumxy=0.0
do 240 j=1,nobs
  xsum=xsum+xadata(j,2)
  xsumsq=xsumsq+(xadata(j,2))**2
  ysum=ysum+ybdata(j,2)
  ysumsq=ysumsq+(ybdata(j,2))**2
  sumxy=sumxy+(xadata(j,2)*ybdata(j,2))
240 continue
c      write (*,*) xsum,ysum,xsumsq,ysumsq,sumxy
c-----find corrected sum of products, covariance
c      and corrected sum of squares (x) (y)
c
  xamean=xsum/nobs
  ybmean=ysum/nobs
  sumprod=sumxy-((xsum*ysum)/nobs)
  covarxy=sumprod/(nobs-1.0)
  xcsumsq=xsumsq-((xsum**2)/nobs)
  ycsumsq=ysumsq-((ysum**2)/nobs)
c
c-----find variance, standard deviation for x and y
c
  xvar=xcsumsq/(nobs-1.0)
  yvar=ycsumsq/(nobs-1.0)
  xstdev=sqrt(xvar)
  ystdev=sqrt(yvar)
c-----find correlation coefficient by Davis method
  corrDxy=covarxy/(xstdev*ystdev)
c-----find slopes, intercepts and correlation
c      coefficient by Young method
  xslope=((nobs*sumxy)-(xsum*ysum))/((nobs*xsumsq)-xsum**2)
  yslope=((nobs*sumxy)-(xsum*ysum))/((nobs*ysumsq)-ysum**2)
  xintcpt=((ysum*xsumsq)-(sumxy*xsum))/((nobs*xsumsq)-xsum**2)
  yintcpt=((xsum*ysumsq)-(sumxy*ysum))/((nobs*ysumsq)-ysum**2)
  corrYxy=sqrt(xslope*yslope)
c
c-----write out this mess for individual pass and
c      overlapping lengths of passes
c
c      write (25,9992) xpassno,ypassno,xvar,yvar,xstdev,ystdev,
c      > xamean,ybmean
9992 format ('FOR OVERLAPPING LENGTHS X=',i5,' Y=',i5,/,
> ' X VARIANCE=',f9.3,' Y VARIANCE=',f9.3,' X STDEV=',
> f9.3,' Y STDEV=',f9.3,' XMEAN=',f9.3,' YMEAN=',f9.3)
c      write (25,9993) covarxy,corrDxy
9993 format ('COVARIANCE XY=',f9.3,' Davis CORRELATION COEF=',f9.3)
c      write (25,9994) xslope,xintcpt,yslope,yintcpt,corrYxy
9994 format ('X SLOPE=',f9.3,' X INTERCEPT=',f9.3,' Y SLOPE=',
> f9.3,' Y INTERCEPT=',f9.3,' Young CORRELATION COEF=',
> f9.3,/)
c
c      write (25,9995) xpassno,ypassno,corrDxy,corrYxy,xvar,yvar,
c      > covarxy,xstdev,ystdev
9995 format (2i5,7(f10.4))
c      write (25,9996) xamean,ybmean,xslope,yslope,xintcpt,yintcpt
9996 format (i0x,6(f10.4))
c      return
c      end
c
c
c
c
c      subroutine average (nobs,choice,prime,crosscnt)
c      real xadata(400,4),ybdata(400,4),avgdatmean,avgdatsum,
c      > avgdata(400,4),nobs
c      integer nobs,choice,prime,crosscnt
c      common /trunstat/ xadata(400,4),ybdata(400,4)
c      common /aver/ avgdata(400,4)
c
c----- subroutine description
c      average calculates the average magnetic value of the
c      input passes. it will also find the average position
c      of the input passes if so directed.
c
  avgdatsum=0.0
  nobss=real(nobs)
c
  if (prime .eq. 2) then
    do 100 i=1,nobs
      avgdata(i,1)=(xadata(i,1)+ybdata(i,1))/2.0
      avgdata(i,2)=(xadata(i,3)+ybdata(i,3))/2.0
      addxy = abs(xadata(i,3)) + abs(ybdata(i,3))
      if (addxy .gt. 270.0) then
        crosscnt=crosscnt+1
        if (ybdata(i,3).gt.0.0 .and. xadata(i,3).lt.0.0) then
          xadata(i,3) = xadata(i,3) + 360.0
        elseif (ybdata(i,3).lt.0.0 .and. xadata(i,3).gt.0.0) then

```

```

        ybdata(1,3) = ybdata(1,3) + 360.0
      endif
      avgdata(1,2) = ((xadata(1,3)+ybdata(1,3))/2.0)
      if (avgdata(1,2) .gt. 180.0)
>        avgdata(1,2) = avgdata(1,2) - 360.0
      endif
      avgdata(1,3) = ((xadata(1,4)+ybdata(1,4))/2.0)
      avgdata(1,4) = ((xadata(1,2)+ybdata(1,2))/2.0)
      avgdatsum = avgdatsum + avgdata(1,4)
100    continue
      avgdatmean = avgdatsum/nobss
      if (choice .eq. 1) then
        do 150 i=1,nobs
          avgdata(i,4) = avgdata(i,4) - avgdatmean
150    continue
        endif
      c
      elseif (prime .eq. 1) then
        do 200 i=1,nobs
          avgdata(i,4) = ((xadata(i,2)+ybdata(i,2))/2.0)
          avgdatsum = avgdatsum + avgdata(i,4)
200    continue
          avgdatmean = avgdatsum/nobss
          if (choice .eq. 1) then
            do 250 i=1,nobs
              avgdata(i,4) = avgdata(i,4) - avgdatmean
250    continue
            endif
          endif
        endif
      c
      return
    end
  c
  c
  c
  subroutine track (nop,noc,prime)
    integer nop,noc,prime
    real radfac,avgdata(400,4),x(400),y(400),xadata(400,4),
>    ybdata(400,4)
    common /aver/ avgdata(400,4)
    common /tplot/ x(400),y(400)
    common /trunstat/ xadata(400,4),ybdata(400,4)
  c
  c----- subroutine description
  c
  c    track finds the lat and long coordinates of the observations
  c    along an orbit.  these coordinates can be plotted as the
  c    trace of the pass along the earth.
  c    NOTE: lat and long are changed to radians for the plotting
  c    package that i use.
  c
    RADFAC=0.017453293
    noc=noc+1
    if (prime .eq. 2) then
      DO 200 J=1,NOP
        x(j)=90.0-avgdata(j,1)
        y(j)=avgdata(j,2)
        if (y(j) .lt. 0.) y(j) = y(j) + 360.
        X(J)=X(J)*RADFAC
        Y(J)=Y(J)*RADFAC
200    CONTINUE
      elseif (prime .eq. 1) then
        do 300 j=1,nop
          x(j) = 90.0 - xadata(j,1)
          y(j) = xadata(j,3)
          if (y(j) .lt. 0.0) y(j) = y(j) + 360.0
          x(j) = x(j) * radfac
          y(j) = y(j) * radfac
300    continue
        endif
      c
      return
    end
  c
  c
  c
  c
  subroutine findgap (global,dndk,minobs,type)
    integer zero,eight,strtotpass,x3row,x3col,x3pass,
>    y3row,y3col,y3pass,cnt,type,strmincnt,
>    dndk,nowant(4000),nocnt,mincnt,
>    minobs,totpass,global,
>    nopass,strnocnt,allcnt,stralldnt
    real y3data(400,3),y3mean,abss,allxdnt(4000,4),
>    allydat(4000,4),x3mean,x3data(400,3),stryone(4)
    common /nope/ nowant(4000),nocnt
  c----- subroutine description
  c
  c    findgap locates the overlapping segment in each of the
  c    two adjacent passes.  this is done by looking at the
  c    first and last latitudes in each pass and comparing
  c    the values.  if there are two passes that do not have
  c    overlapping segments, then one of the two passes

```

```

c      is removed.
c      NOTE: the difference between a latitude gap finder and
c            a minimum observation gap finder is: a latitude
c            finder allows extremely short passes to be worked
c            with in the processing whereas a minimum observation
c            gap finder removes all short passes. the trade off
c            occurs because a minimum observation finder actually
c            allows a higher number of observations to be worked
c            with in collocation. therefore a minobs gap finder
c            is usually best. experiment to see what u like.
c
c      totpass=0
c      allcnt=0
c      strnocnt=nocnt
c
c 10  continue
c      read (10,end=30) x3row,x3col,zero,x3mean,x3pass,eight
c      do 15 i=1,x3row
c          read (10) (x3data(i,i),ii=1,x3col)
c 15  continue
c      totpass=totpass+1
c      if (x3row .lt. minobs) then
c          nowant(nocnt+1)=x3pass
c          nocnt=nocnt+1
c      endif
c      allcnt=allcnt+1
c      allxdat(allcnt,1)=real(x3pass)
c      allxdat(allcnt,2)=real(x3row)
c      allxdat(allcnt,3)=x3data(1,1)
c      allxdat(allcnt,4)=x3data(x3row,1)
c      go to 10
c
c 30  continue
c      strtotpass=totpass
c      strallcnt=allcnt
c      totpass=0
c      allcnt=0
c 31  read (12,end=50) y3row,y3col,zero,y3mean,y3pass,eight
c      do 35 i=1,y3row
c          read (12) (y3data(i,i),ii=1,y3col)
c 35  continue
c      totpass=totpass+1
c      if (y3row .lt. minobs) then
c          nowant(nocnt+1)=y3pass
c          nocnt=nocnt+1
c      endif
c      allcnt=allcnt+1
c      allydat(allcnt,1)=real(y3pass)
c      allydat(allcnt,2)=real(y3row)
c      allydat(allcnt,3)=y3data(1,1)
c      allydat(allcnt,4)=y3data(y3row,1)
c      go to 31
c
c 50  continue
c      if (totpass.ne.strtotpass .or. allcnt.ne.strallcnt) then
c          write (*,*) 'FILES DO NOT HAVE THE SAME NUMBER OF PASSES'
c          write (*,*) 'FILE X PASS COUNT=',strtotpass,strallcnt
c          write (*,*) 'FILE Y PASS COUNT=',totpass,allcnt
c          stop
c      endif
c
c      do 52 ii=1,4
c          stryone(ii)=allydat(1,ii)
c 52  continue
c      do 55 i=1,allcnt-1
c          do 55 ii=1,4
c              allydat(i,ii)=allydat(i+1,ii)
c 55  continue
c      do 57 ii=1,4
c          allydat(allcnt,ii)=stryone(ii)
c 57  continue
c      if (global .eq. 1) allcnt=allcnt-1
c
c      if (type .eq. 2) go to 400
c
c----- work a latitude gap finder
c 70  continue
c      cnt=1
c
c 100 continue
c      if (allxdat(cnt,1) .ne. allydat(cnt,1)) then
c          write (*,*) 'PASSES DO NOT MATCH FOR A-east A-west'
c          write (*,*) 'REVERSE THE ORDER OF INPUT FILES AND RERUN'
c          stop
c      endif
c      if (nocnt .eq. 0) go to 140
c      do 110 i=1,nocnt
c          if (int(allxdat(cnt,1)) .eq. nowant(i)) then
c              if (cnt+1 .gt. allcnt) go to 190
c              do 105 jj=cnt,allcnt-1

```



```

        do 105 j=1,4
            allxdat(jj,j)=allxdat(jj+1,j)
            allydat(jj,j)=allydat(jj+1,j)
105      continue
        allcnt=allcnt-1
    endif
110  continue
140  continue
    abss=abs(allxdat(cnt,3)-allydat(cnt,3))
    if (abss .lt. 0.33) go to 190
    if (abss .ge. 0.33) then
        nopass=int(allxdat(cnt,1))
c-----if this is a dusk pass then will count from
c          -90.0 lat degrees toward the equator
        if (dndk .eq. 0) then
            if (allxdat(cnt,3) .gt. allydat(cnt,3)) then
                if (allxdat(cnt,3) .gt. allydat(cnt,4)) then
                    nocnt=nocnt+1
                    nowant(nocnt)=nopass
                endif
            elseif (allxdat(cnt,3) .lt. allydat(cnt,3)) then
                if (allxdat(cnt,4) .lt. allydat(cnt,3)) then
                    nocnt=nocnt+1
                    nowant(nocnt)=nopass
                endif
            endif
        endif
c-----if this is a dawn pass then will count from
c          the equator toward the south pole
c          that is decreasing independent variable
        elseif (dndk .eq. 1) then
            if (allxdat(cnt,3) .lt. allydat(cnt,3)) then
                if (allxdat(cnt,3) .lt. allydat(cnt,4)) then
                    nocnt=nocnt+1
                    nowant(nocnt)=nopass
                endif
            elseif (allxdat(cnt,3) .gt. allydat(cnt,3)) then
                if (allxdat(cnt,4) .gt. allydat(cnt,3)) then
                    nocnt=nocnt+1
                    nowant(nocnt)=nopass
                endif
            endif
        endif
    endif
190  continue
    cnt=cnt+1
    if (cnt .gt. allcnt) go to 200
    go to 100
c
200  continue
    if (nocnt .eq. strnocnt) go to 999
    if (strnocnt .lt. nocnt) then
        strnocnt=nocnt
        go to 70
    endif
c
c----- work a minimum observations gap finder
400  continue
    mincnt=0
    strmincnt=mincnt
c
470  continue
    cnt=1
c
500  continue
    if (allxdat(cnt,1) .ne. allydat(cnt,1)) then
        write (*,*) 'PASSES DO NOT MATCH FOR A-east A-west'
        write (*,*) 'REVERSE THE ORDER OF INPUT FILES AND RERUN'
        stop
    endif
    if (int(allxdat(cnt,2)) .lt. minobs .or.
>      int(allydat(cnt,2)) .lt. minobs) then
        if (cnt+1 .gt. allcnt) go to 590
        do 505 jj=cnt,allcnt-1
            do 505 j=1,4
                allxdat(jj,j)=allxdat(jj+1,j)
                allydat(jj,j)=allydat(jj+1,j)
505      continue
        allcnt=allcnt-1
        go to 500
    endif
510  continue
540  continue
    abss=abs(allxdat(cnt,3)-allydat(cnt,3))
    if (abss .lt. 0.33) go to 590
    if (abss .ge. 0.33) then
        xrow=int(allxdat(cnt,2))
        yrow=int(allydat(cnt,2))
        minxyrow=min(xrow,yrow)

```

```

mincnt2=mincnt
c-----if this is a dusk pass then will count from
c          -90.0 lat degrees toward the equator
      if (dndk .eq. 0) then
        if (allxdat(cnt,3) .gt. allydat(cnt,3)) then
          if (allxdat(cnt,3) .gt. allydat(cnt,4)) mincnt=mincnt+1
        elseif (allxdat(cnt,3) .lt. allydat(cnt,3)) then
          if (allxdat(cnt,4) .lt. allydat(cnt,3)) mincnt=mincnt+1
        endif
c-----if this is a dawn pass then will count from
c          the equator toward the south pole
c          that is decreasing independent variable
      elseif (dndk .eq. 1) then
        if (allxdat(cnt,3) .lt. allydat(cnt,3)) then
          if (allxdat(cnt,3) .lt. allydat(cnt,4)) mincnt=mincnt+1
        elseif (allxdat(cnt,3) .gt. allydat(cnt,3)) then
          if (allxdat(cnt,4) .gt. allydat(cnt,3)) mincnt=mincnt+1
        endif
      endif
      if (mincnt .gt. mincnt2) minobs=minxyrow+1
    endif
  c
  c
  590 continue
      cnt=cnt+1
      if (cnt .gt. allcnt) go to 600
      go to 500
c
  600 continue
      if (mincnt .eq. strmincnt) go to 999
      if (strmincnt .lt. mincnt) then
        strmincnt=mincnt
        go to 470
      endif
c
  999 continue
      write (*,*) 'total passes read = ',totpass
      if (nocnt .gt. 0) then
        write (*,*) 'will remove the following passes from processing'
        do 1010 i=1,nocnt
          write (*,*) nowant(i),1
        1010 continue
      endif
      if (type .eq. 2) write (*,*) 'new minimum observation cutoff',
>      ' is =',minobs
      rewind (10)
      rewind (12)
c
      return
    end

```

B-85

B-85

00 1980. MAGSAT12/83 FIELD MODEL				
2	1	-29986.5977	0	26.5047
2	2	-1956.0098	5603.8984	11.9441
3	1	-1996.6699	0	-17.7715
3	2	3027.3098	-2129.2998	3.5560
3	3	1662.6899	-199.7370	03.1459
4	1	1281.4099	0	01.2007
4	2	-2180.5198	-335.5408	-3.6188
4	3	1250.8599	270.8979	-1.1017
4	4	832.8589	-252.2290	1.8474
5	1	937.6270	0	-.6511
5	2	782.2798	212.1880	-2.0523
5	3	397.8979	-256.6948	-5.8275
5	4	-418.9170	52.8622	-2.4301
5	5	198.8960	-297.1729	-2.7610
6	1	-217.8750	0	.0000
6	2	357.2400	45.9779	-0.0000
6	3	261.0259	149.8220	-1.2862
6	4	-74.2543	-150.6240	-4.1370
6	5	-161.9080	-77.7266	-1.3131
6	6	-48.0216	92.1005	00.0000
7	1	47.9521	0	1.5744
7	2	65.5112	-14.7623	0.3746
7	3	41.9219	93.0835	.9571
7	4	-192.1090	70.5787	1.2512
7	5	3.5873	-43.0699	.6488
7	6	13.8212	-2.2228	.8309
7	7	-107.7240	17.2125	01.5749
8	1	71.9145	0	1.3718
8	2	-59.2225	-82.4974	-0.7318
8	3	1.6950	-27.4258	.3371
8	4	20.7407	-4.9118	.0000
8	5	-12.4245	16.2844	0.7764
8	6	.6345	17.7860	-0.0000
8	7	10.5919	-23.0138	0.0000
8	8	-1.6744	-9.6949	1.7731
9	1	18.4829	0	0.7492
9	2	6.5464	6.8482	0
9	3	-.4431	-17.7074	0.3060
9	4	-10.9846	4.2139	
9	5	-6.9316	-22.1996	-.8890
9	6	4.2292	9.1278	.2806
9	7	2.7169	16.0818	
9	8	6.0254	-13.2103	
9	9	-1.3743	-14.5602	-2.2246
10	1	5.2888	0	-.2980
10	2	10.3522	-20.8464	
10	3	1.3838	15.5210	.4694
10	4	-12.3472	8.7402	
10	5	9.4401	-5.3002	
10	6	-3.4208	-6.3179	-.0717
10	7	-1.1873	9.0043	
10	8	6.7100	9.6459	
10	9	1.4932	-5.9579	-.4223
10	10	-4.9898	1.9550	-1.0560
11	1	-3.4630	0	.8585
11	2	-4.0062	1.2249	
11	3	2.2272	.5099	-.4740
11	4	-5.4032	2.6612	-.2979
11	5	-1.9878	5.7745	.7246
11	6	4.5775	-4.2379	
11	7	3.1480	-.4134	
11	8	.9039	-1.3354	-.6724
11	9	1.9700	3.5658	1.2551
11	10	2.8069	-.4729	.1466
11	11	-.2741	-6.1331	-.5215
12	1	2.4795	0	
12	2	-1.1335	.6132	
12	3	-1.6582	1.7210	
12	4	2.1526	-1.3117	
12	5	.0610	-3.1316	
12	6	-.6072	.7970	
12	7	-.3238	-.0409	
12	8	1.6151	-2.4801	
12	9	1.7163	-.3808	
12	10	-.7606	-1.6667	
12	11	2.0084	-1.5290	
12	12	3.4451	0.7629	
13	1	-1.7069	0	
13	2	-.1409	.2182	
13	3	-.2764	.7604	
13	4	-.2045	2.5462	
13	5	.6790	-1.4956	
13	6	.6367	.3952	
13	7	-.4485	.2423	
13	8	-.1787	-.2355	
13	9	.2656	.0192	
13	10	-.4602	-.0133	
13	11	0.1407	-1.2097	
13	12	.5953	.3708	

13	13	-.1378	.4564			
14	1	-.2049	0			
14	2	-.5967	-.4816			
14	3	.3725	.3039			
14	4	-.8791	1.4826			
14	5	-.1829	-.2216			
14	6	1.1048	-.4758			
14	7	-.4404	-.2088			
14	8	.3847	.7995			
14	9	-.4823	.0535			
14	10	.1867	.8530			
14	11	-.1106	.0633			
14	12	.3455	-.1350			
14	13	-.0851	0.2500			
14	14	.3797	-.3348			
-1	0	0.	0.	0.	0.	0.



## **APPENDIX C: MAP PROCESSING**

### **PROGRAMS**

collocation.f

fourier2d.f

avgdifres.f

sqrmap.f

inversion.f

### **DATA FILE**

rmagcov





```

C      program collocation
C      *****
C      THIS PROGRAM READS A FILE OF IRREGULARLY DISTRIBUTED
C      DATA POINTS (LATITUDE, LONGITUDE, ELEVATION, ANOMALY
C      VALUE) AND PREDICTS THE GRIDDED ANOMALIES ON A GRID OF
C      SPECIFIED DENSITY. THE ANOMALY ESTIMATE FOR EACH GRID
C      LOCATION IS OBTAINED FROM NCPP NEAREST SAMPLE POINTS
C      USING A LOCAL COVARIANCE MODEL. THE PROCEDURE KNOWN AS
C      LEAST-SQUARES COLLOCATION INVOLVES THE FOLLOWING STEPS:
C
C      1. REMOVE THE MEAN OF THE ANOMALIES IN THE PREDICTION
C      AREA TO OBTAIN RESIDUALS CENTERED AROUND MEAN
C      2. SEARCH FOR THE NCPP CLOSEST DATA POINTS TO THE GRID
C      LOCATION AND STORE THEM IN VECTOR (M1)
C      3. FORM THE COVARIANCE MATRIX (COVM) OF THE NCPP DATA
C      POINTS
C      4. ADD THE ERROR VARIANCE OF THE DATA POINTS TO THE
C      DIAGONAL OF 'COVM' MATRIX, TO FORM THE FINAL 'COVM'
C      MATRIX
C      5. INVERT 'COVM' MATRIX AND STORE THE RESULT AGAIN IN
C      'COVM'
C      6. FORM THE CROSS-COVARIANCE VECTOR (T1) BETWEEN THE
C      GRID VALUE TO BE PREDICTED AND THE NCPP DATA POINTS
C      7. BY LEAST SQUARES COLLOCATION, THE ANOMALY ESTIMATE
C      IS GIVEN AS:
C
C      TP=T1*COVM*M1
C
C      AND THE STANDARD ERROR OF PREDICTION IS GIVEN BY,
C
C      SEP=DSQRT(VAR-T1*COVM*T1)
C
C      VAR...COVARIANCE AT ZERO SEPARATION (I.E. VARIANCE)
C
C      THE ABOVE EQUATIONS INVOLVE THE MATRIX OPERATIONS.
C      *****
C      PRELIMINARY SOFTWARE EXPLICITLY DEVELOPED FOR GRAVITY
C      PREDICTION OVER A SPHERICAL SURFACE WAS MADE AVAILABLE
C      BY GEODETIC SCIENCE DEPARTMENT AT THE OHIO STATE
C      UNIVERSITY. IT WAS MODIFIED FOR NASA MAGNETIC SATELLITE
C      APPLICATION FOR 3-D PREDICTION AND THEREBY ALTITUDE
C      NORMALIZATION.
C
C      MODIFICATIONS BY: HARISH K. GOYAL
C                       DEPT. OF GEOL & MIN, OSU
C                       TEL. 422-1434, CAMPUS
C                       MAR, 1986
C
C      1. LATITUDES ARE CHANGED TO CO-LATITUDES TO COMPLY
C      WITH SPHERICAL COORDINATES.
C      2. SEPARATION DISTANCES ARE THE RADIAL VECTORS TO
C      ACCOUNT FOR THREE DIMENSIONAL VARIABILITY
C      3. COVARIANCES ARE AUTOMATICALLY SCALED IN THE
C      PROGRAM
C
C      further modifications 11 may 90
C      these modifications are all lower case letters
C
C      well'p just a few more modifications on 8 sep 90
C      these changes are: 1) removal of unnecessary arrays
C      2) changing all arrays to real*4 and not real*8
C      3) keeping all arrays that work with the inversion as
C      real*8. 4) removing every blasted 'nbug' statement i could
C      get my hands on!! 5) reading the data once storing everything in
C      memory -ie. not reading the data twice. 6) changing all logical
C      true and false statements to user friendly statements.
C      7) this program could be faster by inverting only the half of
C      the symmetric covariance matrix (covm) and there probably is a
C      faster routine for searching for the closest points.
C      *****
C      INPUT PARAMETERS .....
C
C      NORTH...NORTH LATITUDE OF DATA AREA
C      SOUTH...SOUTH LATITUDE OF DATA AREA
C      WEST...WEST LONGITUDE OF DATA AREA
C      EAST...EAST LONGITUDE OF DATA AREA
C      note: use the following example if you want an equal-
C      area projection. say you are working at the south
C      pole from -40S to -83S and including all longitudes.
C      then instead of choosing north=-40, south=-83,
C      west=-180 and east=180 (which are appropriate for
C      non-equal area degrees) choose instead:
C      north=55, south=-55, west=-55, east=55. 55 comes
C      from the following calculation. from -40 to

```

```

c      -83 degrees is 43 points, however, an equal area
c      projection will go all the way to the pole because
c      the pole will be centered at the middle of the grid
c      (unlike the non-equal area degree projection where
c      the pole is at the southern edge of the grid) so,
c      from -40 to -90 is 50 points and you should add a few
c      points for a rind around the edge, say 5 points.
c      55=50+5. get it? now, if you are going to work with
c      an equal area projection, you MUST transform the
c      coordinates of the input data points from the degree
c      domain to the spatial domain. program getllraspc.f does
c      this transformation. also, if you want to convert a
c      grid from/to equal-area to/from non-equal degree then
c      use program deg2spc.f to do the coordinate transform
c      and use collocation to get the values at the new grid
c      coordinates. clear as mud, eh? email me at
c      alsdorf@geols.mps.ohio-state.edu
c      if you need help.
c
c      NX...NO. OF GRID PTS IN THE LONG. DIRECTION, MINUS ONE
c      NY...NO. OF GRID PTS IN THE LAT. DIRECTION, MINUS ONE
c      NCOV...NUMBER OF ENTRIES IN COVARIANCE FUNCTION
c      and is determined by the program
c      NCPP...NO. OF NEAREST POINTS USED FOR PREDICTION
c      ELEV...COMMON ALTITUDE FOR GRIDDED ANOMALY DATA
c      and is in kilometers from --SURFACE-- of the earth
c      ESTD...STANDARD DEVIATION OF OBSERVATIONAL ERROR
c      (ERROR VARIANCE=ESTD**2)
c      from read of file 10
c      THI...LATITUDE COORDINATE
c      PHI...LONGITUDINAL COORDINATE
c      RAD...RADIUS VECTOR FROM --CENTER-- OF THE EARTH
c      ANO...ANOMALY VALUE
c
c
c      GRID DIMENSIONS AS FOLLOWS:
c      the following arrays = (ny+1)*(nx+1):
c      x,y,tp,ifc,ih,sep
c      the following arrays must be equal to or greater than
c      the maximum number of data points:
c      rrad,rthl,rphi,tano,dist,thii,phii,radd,anom
c      ARRAYS CNN,DNUM MUST ACCOMMODATE THE NUMBER OF ENTRIES
c      IN COVARIANCE FUNCTION
c
c      CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
c      IMPLICIT REAL(A-H,O-Z)
c      DIMENSION X(20000),Y(20000),TP(20000),CNN(500),
c      . DNUM(500),RRAD(200000),RTHI(200000),RPHI(200000),
c      . TANO(200000),
c      . DIST(200000),IFC(20000),thii(200000),phii(200000),
c      > radd(200000),anom(200000),IH(20000),SEP(20000)
c      REAL NORTH
c      real thi,phi,rad,anom,cross
c      integer totpts
c      character*80 filename
c      character*5 yesno
c      real dnum,cnn,scale,sumsq
c      COMMON/ONE/ CNN,DNUM,NCOV
c      COMMON/TWO/ SCALE
c      DATA RHO,NPTS/57.2957795,0/
c
c      write (*,*) 'INPUT COVARIANCE MATRIX'
c      read (*,9990) filename
c      9990 format (a80)
c      open (1, file=filename,status='old',form='formatted')
c      write (*,*) 'INPUT FILE OF ALL DATA POINTS LAT LON RAD ANOM'
c      read (*,9990) filename
c      open (10, file=filename,status='old',form='formatted')
c      write (*,*) 'OUTPUT FILE OF GRIDDED DATA POINTS'
c      read (*,9990) filename
c      open (20, file=filename,form='formatted')
c      write (*,*) 'OUTPUT INFORMATION FILE'
c      read (*,9990) filename
c      open (21, file=filename,form='formatted')
c
c
c      write (*,*) 'BARF-- NORTH SOUTH EAST WEST AS 90.0 TO -90.0',
c      > ' AND 180.0 TO -180.0'
c      read (*,*) north,south,east,west
c      write (*,*) 'NUMBER OF GRID POINTS MINUS ONE IN THE NS DIRECTION'
c      write (*,*) 'NUMBER ----- EW -----'
c      write (*,*) 'NS, EW '
c      read (*,*) ny,nx
c      write (*,*) 'POINT SIZE OF WINDOW FOR SEARCH AREA (20)'
c      read (*,*) ncpp
c      write (*,*) 'ELEVATION OF PREDICTION FOR GRID (350.0 Km)'
c      write (*,*) '(--NOT-- radius = 6378.140 Km)'
c      read (*,*) elev
c      elev=elev+6378.140

```

```

        write (*,*) 'STANDARD DEVIATION OF OBSERVATIONAL ERROR (1.0)'
        read (*,*) estd
        write (*,*) 'REMOVE THE MEAN FROM THE GRID BEFORE WRITTING'
        write (*,*) 'y OR n'
        read (*,9991) yesno
9991 format (a5)
C
      If(EAST.EQ.WEST.OR.NORTH.LE.SOUTH.OR.NY.LE.O.OR.NX.
        LE.O) STOP 9999
C
      CHANGE LATITUDES TO SPHERICAL COORDINATES
C
      NORTH=90.0-NORTH
      SOUTH=90.0-SOUTH
C
C----- the program is checking for the -180.0 180.0 meridian
C
      cross=0.0
      IF(WEST.GT.EAST) cross=360.0
      EAST=EAST + cross
C
      INPUT THE COVARIANCE TABLE
C
      I=1
5     read (1,*,end=7) dnum(i),cnn(i)
      i=i+1
      go to 5
7     ncov=i-1
      SCALE=CNN(1)
C
      GRID SPACING ..ie: interval between grid nodes = dl and dp
C
      DP=(NORTH-SOUTH)/FLOAT(NY)
      DL=( EAST-WEST )/FLOAT(NX)
C
C .. DETERMINE THE OVERLAPS IN X AND Y-DIRECTIONS
C
      YOVLAP=DP/2.
      XOVLAP=DL/2.
C
C .. NXPl,NYP1 = NUMBER OF SORT ELEMENTS IN X AND Y-DIR.
C .. XLL,XUP = LOWER AND UPPER X LIMITS OF SORT RANGE
C .. YLL,YUP = LOWER AND UPPER Y LIMITS OF THE SORT RANGE
C .. NX,NY = NUMBER OF DIVISIONS ALONG X AND Y AXES
C DETERMINE X,Y COORDINATES OF GRID INTERSECTIONS
C
      NXPl=NX + 1
      NYP1=NY + 1
      DO 10 I=1,NYP1
        YY=DP*(I-1)+YOVLAP
        DO 10 J=1,NXPl
          K=J+NXPl*(I-1)
          Y(K)=YY
          X(K)=DL*(J-1)+XOVLAP
10     CONTINUE
C
      DETERMINE THE X,Y COORDINATES OF THE DATA AREA AND
      GRID SPACING
C
      XLL=0.
      XUP=X(NXPl)+XOVLAP
      YLL=0.
      YUP=Y(NXPl*NYP1)+YOVLAP
      DXX=NXPl/(XUP-XLL)
      DYY=NYP1/(YUP-YLL)
C
      DETERMINE BOUNDARIES FOR DATA SELECTION
C
      THIS=SOUTH-YOVLAP
      THIN=NORTH+YOVLAP
      EPHI=EAST+XOVLAP
      WPHI=WEST-XOVLAP
C----- varn is a constant for input to subroutine
C          prdt. varn should be change to an array for
C          corresponding individual data points if each
C          data point or group of data points need to have
C          individually different error variances.
C
      varn=estd**2
C
      write (21,*) 'north colatitude =',north,' south colat =',south
      write (21,*) 'east longitude =',east,' west long =',west
      write (21,*) 'dp =',dp,' dl =',dl,' xovlap =',xovlap,
>      ' yovlap =',yovlap
      write (21,*) 'thin =',thin,' this =',this,' ephi =',ephi,
>      ' wphi =',wphi
      write (21,*) 'xll =',xll,' xup =',xup,' yll =',yll,' yup =',yup
      write (21,*) 'dxx =',dxx,' dyy =',dyy
      write (21,*) 'error variance =',varn,
>      ' standard deviation error =',estd
C

```

```

C INPUT ADJUSTED MAGNETIC DATA AND SELECT DATA FOR
C THE PREDICTION
C
      np=(nxp1+1)*(nyp1+1)
      do 15 i=1,np
        ifc(i)=0
15      continue
C
      AMEAN=0.0
      totpts=0
20      read (10,*,end=30) thi,phi,rad,anomaly
      totpts=totpts+1
      THI=90.0-THI
      IF (THI.GE.THIS) GO TO 20
      IF (THI.LE.THIN) GO TO 20
      IF (PHI .LT. 0.0) PHI=PHI + cross
      IF (PHI.LE.WPHI) GO TO 20
      IF (PHI.GE.EPHI) GO TO 20
      NPTS=NPTS + 1
      AMEAN=AMEAN + anomaly
      RX=PHI-WPHI
      RY=THI-THIS
C
C IX AND IY IDENTIFIES THE BLOCK TO WHICH DATA FALL INTO
C AND IYJX ASSIGNS AN IDENTIFIER TO DATA CORRESPONDING TO
C THAT BLOCK
C
      IY=INT((RY-YLL)*DYY)+1
      JX=INT((RX-XLL)*DXX)+1
      IYJX=(IY-1)*NXP1+JX
C
C .. IFC = COUNTER VECTOR , STORES NUMBER OF DATA PER
C SORT ELEMENT
C
      IFC(IYJX)=IFC(IYJX)+1
C
      thii(npts)=thi
      phi1(npts)=phi
      radd(npts)=rad
      anom(npts)=anomaly
C
      GO TO 20
C
30      continue
      if (npts .le. 1) stop 111
C
      AMEAN=AMEAN/FLOAT(NPTS)
C
      WRITE(21,*) 'total points selected =',npts
      write (21,*) 'total points read =',totpts
      write (21,*) 'mean of selected points =',amean
      write (*,*) 'finished reading data set'
C
C IH = POINTER VECTOR, FOR CORRESPONDING BLOCK ATTAINS
C A VALUE EQUAL TO SUM OF DATA IN PREVIOUS BLOCKS + 1
C
      ND=NXP1*NYP1
      IH(1)=1
      DO 87 I=2,ND
        I1=I-1
        IH(I)=IFC(I1)+IH(I1)
87      CONTINUE
C
C TX,TY,RTHI,RPHI,RRAD,TANO,VARN ARE NUMBERED FOR
C CORRESPONDING DATA, IN EACH BLOCK NUMBERING STARTS
C WITH IH VALUE FOR THAT BLOCK AND INCREMENTED BY 1 FOR
C NEXT DATA IN THE BLOCK
C
C the mean anomaly value is removed here rather than in subroutine prdt.
C also the sum of squares is calculated here and transferred to
C subroutine prdt.
C
      sumsqr=0.0
      DO 85 I=1,NPTS
        rx=phi1(i)-wphi
        ry=thii(i)-this
        IY=INT((RY-YLL)*DYY)+1
        JX=INT((RX-XLL)*DXX)+1
        IYJX=(IY-1)*NXP1+JX
        NUM=IH(IYJX)
        TANO(NUM)=anom(i)-amean
        sumsqr=sumsqr+(dble(tano(num))*dble(tano(num)))
        RTHI(NUM)=thii(i)
        RPHI(NUM)=phi1(i)
        RRAD(NUM)=radd(i)
        IH(IYJX)=IH(IYJX)+1
85      CONTINUE
C
C IH(I) ATTAINS THE VALUE EQUAL TO NUMBER OF SAMPLE
C POINTS IN PREVIOUS BLOCKS + 1

```

```

C      DO 86 I=1,ND
C          IH(I)=IH(I)-IFC(I)
86      CONTINUE
C          IH(ND+1)=NPTS+1
C
C      SUBROUTINE PRDT PREDICTS ANOMALIES AND ERRORS OF
C      STANDARD DEVIATION AT EACH GRID LOCATION
C
C      write (*,*) 'calculating anomaly values'
C
C      CALL PRDT(NPTS,NYP1,NXP1,X,Y,TP,RTHI,RPHI,DIST,
C      .        VARN,THIS,TANO,NORTH,SOUTH,EAST,WEST,IH,DXX,DYY,DP,
C      .        DL,AMEAN,RRAD,NCPP,ELEV,SEP,sumsq)
C
C      WRITE THE VALUES OF THE PREDICTED Z-AXIS VALUES
C      (ANOMALIES) AND THEIR ERROR OF STANDARD DEVIATIONS.
C      THE ROWS ARE LISTED WITH LATITUDES STARTING SOUTH
C      AND INCREMENTING TO NORTH.
C
C      if (yesno .eq. 'y') then
C          np=nxp1*nyp1
C          do 380 i=1,np
C              totgrid=tp(i)+totgrid
380      continue
C          avgrid=totgrid/real(np)
C          do 390 i=1,np
C              tp(i)=tp(i)-avgrid
390      continue
C          write (21,*) 'total mean removed from the grid =',avgrid
C      endif
C
C      WRITE(21,9600) WEST,DL
C      write (20,*) nxpl
C      write (20,*) nyp1
C      write (20,*) south
C      write (20,*) west
C      write (20,*) dl
C      P=SOUTH
C      DO 400 I=1,NYP1
C          ID1=(I-1)*NXP1+1
C          ID2=ID1+NXP1-1
C          WRITE(21,9601) P, (TP(J),J-ID1,ID2)
C          WRITE(20,'(6F13.5)') (TP(J),J-ID1,ID2)
400      P=P + DP
C
C      WRITE(21,9602) WEST,DL
C      P=SOUTH
C      DO 420 I=1,NYP1
C          ID1=(I-1)*NXP1+1
C          ID2=ID1+NXP1-1
C          WRITE(21,'(6F13.5)') (SEP(J),J-ID1,ID2)
420      P=P + DP
C
C      9600 FORMAT(/,'PREDICTED Z-AXIS VALUES',/,
C      .        'STARTING LONGITUDE=',F9.3,'; INCREMENT=',F5.2,/)
C      9601 FORMAT('LAT=',F8.2,2X,80(8F8.2,/,14X))
C      9602 FORMAT(/,'PREDICTED STANDARD DEVIATIONS',/,
C      .        'STARTING LONGITUDE=',F9.3,'; INCREMENT=',F5.2,/)
C
C      STOP
C      END
C
C
C
C
C      SUBROUTINE PRDT(NPTP,MY,MX,X,Y,TP,LAT,LONG,DIST,
C      .        NSEe,THIS,M1,THI1,THI2,PHI1,PHI2,IH,DXX,DYY,DP,DL,
C      .        AMEAN,RC,NCPP,ELEV,SEP,sumsq)
C      IMPLICIT REAL (A-H,O-Z)
C      REAL NSEe,LAT,LONG,M1
C      real scale,covm,fact,sumsq,var,nse,dummy,b,
C      >      t1,t2,tem,tem2,cov
C      DIMENSION LAT(1),LONG(1),DIST(1),M1(1),RC(1),
C      >      X(1),Y(1),TP(1),IH(1),SEP(1)
C      DIMENSION COVM(110,110),B(110),T1(110),T2(110),LCC(110)
C      COMMON/TWO/ SCALE
C      DATA DMAX/6E6/
C      EQUIVALENCE (B(1),T1(1))
C-----
C      this subroutine is one big do loop that progresses through
C      the grid nodes to determine the magnitude at each node.
C
C      nse=dble(nsee)
C      CON1=57.2957795
C      ND=MY*MX
C      NBAD=0
C      YLL=0.0

```

```

      XLL=0.0
C
C   CALCULATE THE SCALING FACTOR FOR THE COVARIANCE TABLE
C
      fact = (sumsq/dble(nptp))/scale
C
      CALL COVINT(0.0,FACT,VAR)
C
      write (21,*) 'sum of squares =',sumsq,' scaling factor =',FACT
      write (21,*) 'zero separation variance =',var
C
      NCPM1=NCPP-1
      IND=0
C
C   P AND Q ARE THE LATITUDE AND LONGITUDE OF THE
C   PREDICTED POINT
C
      write (21,*) ' '
      write (21,*) 'the following data indicate areas where the'
      write (21,*) 'prediction was bad'
      write (21,*) 'lat lon x grid node y gridnode id1 id2 ',
>      'bad point number of total points'
C
      DO 10 IPT=1,MY
      IM=IPT-1
      P=THI2+IM*DP
      DO 10 JPT=1,MX
      JM=JPT-1
      Q=PHI2+JM*DL
      IND=IND+1
      XPP=X(IND)
      YPP=Y(IND)
      DO 7 I=1,NCPP
      LCC(I)=0
C
C   DISTANCE TO ALL POINTS IN THE WINDOW FROM PREDICTION
C   POINT
C
      IY=INT((YPP-YLL)*DYY)+1
      JX=INT((XPP-XLL)*DXX)+1
      IYJX=(IY-1)*MX+JX
      ID1=IH(IYJX)
      ID2=IH(IYJX+1)
      IF((ID2-ID1).GE.NCPP) GO TO 100
C
C   NOT ENOUGH DATA IN FIRST WINDOW,SO CONSIDER NEXT
C   WINDOW
C
      IY1=IY
      IY2=IY
      DO 17 IC=1,MY
      NDATA=0
      IY1=IY-IC
      IY2=IY+IC
      IF(IY1.LT.1) IY1=1
      IF(IY2.GT.MY) IY2=MY
      JX1=JX-IC
      JX2=JX+IC
      IF(JX1.LT.1) JX1=1
      IF(JX2.GT.MX) JX2=MX
      DO 18 IL=IY1,IY2
      IYJX1=(IL-1)*MX+JX1
      ID1=IH(IYJX1)
      IYJX2=IYJX1+JX2-JX1+1
      ID2=IH(IYJX2)
      NDATA=NDATA+ID2-ID1
18      CONTINUE
      IF(NDATA.GE.NCPP) GO TO 100
      NBAD=NBAD+1
C----- write the bad point to file
C
      WRITE (21,800) P,Q,XPP,YPP,ID1,ID2,NBAD,ND
800      FORMAT(4(1X,F12.5),4I6)
17      CONTINUE
100      CONTINUE
      DO 211 IC=IY1,IY2
      IF(IY1.EQ.IY2) GO TO 106
      IYJX1=(IC-1)*MX+JX1
      ID1=IH(IYJX1)
      IYJX2=IYJX1+JX2-JX1+1
      ID2=IH(IYJX2)-1
      IF(ID2.LT.ID1) GO TO 211
106      DO 210 I=ID1,ID2
      DELC=COS(LAT(I)/CON1)*COS(P/CON1)+SIN(LAT(I)/CON1)*
>      SIN(P/CON1)*COS((LONG(I)-Q)/CON1)
      PART1=ELEV**2 + RC(I)**2
      PART2=2.0*ELEV*RC(I)
      DARGU=PART1-PART2*DELC
      IF(DARGU.LE.0.0) THEN
      DIST(I)=0.0

```

```

ELSE
  DIST(I)=SQRT(DARGU)
END IF
210 CONTINUE
211 CONTINUE
C SEARCH FOR NCPP NEAREST POINTS TO PREDICTION POINT
C
220 DO 260 J=1,NCPP
  IF (LCC(J).GT.0) GO TO 260
  DMIN=DMAX
  DO 253 IC=IY1,IY2
    IF (IY1.EQ.IY2) GO TO 107
    IYJX1=(IC-1)*MX+JX1
    ID1=IH(IYJX1)
    IYJX2=IYJX1+JX2-JX1+1
    ID2=IH(IYJX2)-1
    IF (ID2.LT.ID1) GO TO 253
107 DO 250 I=ID1,ID2
    IF (DIST(I)-DMIN) 230,250,250
230 IF (DIST(I)) 250,240,240
240 DMIN=DIST(I)
    LMIN=I
  CONTINUE
250 CONTINUE
253 DIST(LMIN)=--DMIN
  LCC(J)=LMIN
260 CONTINUE
  IF (LCC(NCPP).NE.0) GO TO 258
  GO TO 220
258 CONTINUE
C FORM COVARIANCE MATRIX
C
DO 280 I=1,NCPP1
  M=LCC(I)
  COVM(I,I)=dble(VAR+NSE)
  K=I+1
  DO 280 J=K,NCPP
    N=LCC(J)
    DELC=COS(LAT(M)/CON1)*COS(LAT(N)/CON1)+SIN(LAT(M)/
    CON1)*SIN(LAT(N)/CON1)*COS((LONG(M)
    -LONG(N))/CON1)
    PART1=RC(M)**2 + RC(N)**2
    PART2=2.0*RC(M)*RC(N)
    DARGU=PART1-PART2*DELC
    IF (DARGU.LE.0.0) THEN
      DIS=0.0
    ELSE
      DIS=SQRT(DARGU)
    END IF
    CALL COVINT(DIS,FACT,COV)
    COVM(J,I)=dble(COV)
    COVM(I,J)=dble(COV)
280 CONTINUE
    COVM(NCPP,NCPP)=dble(VAR+NSE)
C----- covm array dimensioned at
C (ncpp,ncpp) is the input matrix
C INVERT COVARIANCE MATRIX
C
COVM(1,1)=1.0/COVM(1,1)
DO 340 I=1,NCPP1
  L=I+1
  DO 300 J=1,I
    B(J)=0.0
  DO 310 J=1,I
    DO 310 K=1,I
      B(J)=B(J)-COVM(K,J)*COVM(L,K)
    Dummy=COVM(L,L)
  DO 320 J=1,I
    Dummy=B(J)*COVM(L,J)+Dummy
    Dummy=1.0/Dummy
  DO 330 J=1,I
    COVM(J,L)=B(J)*Dummy
    COVM(L,J)=B(J)*Dummy
  DO 330 K=1,I
    COVM(J,K)=COVM(J,K)+B(K)*B(J)*Dummy
330 COVM(L,L)=Dummy
340
C----- covm array dimensioned at
C (ncpp,ncpp) is now inverted
C
DO 410 I=1,NCPP
  N=LCC(I)
  DELC=COS(LAT(N)/CON1)*COS(P/CON1)+SIN(LAT(N)/CON1)*
  SIN(P/CON1)*COS((LONG(N)-Q)/CON1)
  PART1=RC(N)**2 + ELEV**2

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      PART2=2.0*ELEV*RC(N)
      DARGU=PART1-PART2*DELC
      IF (DARGU.LE.0.0) THEN
        DIS=0.0
      ELSE
        DIS=SQRT(DARGU)
      END IF
C
      CALL COVINT(DIS,FACT,COV)
C
410    T1(I)=dble(COV)
C
      DO 430 I=1,NCPP
        TEM=0.0
        DO 420 J=1,NCPP
          TEM=COVM(J,I)*T1(J)+TEM
420    T2(I)=TEM
C
        TEM=0.0
        TEM2=0.0
        DO 440 I=1,NCPP
          M=LCC(I)
          TEM=dble(M1(M))*T2(I)+TEM
          TEM2=T1(I)*T2(I)+TEM2
440    CONTINUE
C
C  COMPUTE ANOMALY ESTIMATE AND STANDARD ERROR OF PREDICTION
C
      TP(IND)=real(TEM)+AMEAN
      IF (VAR.LT.TEM2) GO TO 444
      SEP(IND)=SQRT(VAR-TEM2)
      GO TO 445
444    SEP(IND)=1.5
      WRITE(21,446) VAR,TEM2
446    FORMAT('VARIANCE =',F7.2,'TEM2 =',F7.2,'SEP',
      ' TAKEN AS 1.5 NT')
445    CONTINUE
10    CONTINUE
C
      RETURN
      END
C
C
C
C
      SUBROUTINE COVINT(DIS,FACT,COV)
      IMPLICIT REAL (A-H,O-Z)
      real dis
      integer ncov
      DIMENSION CNN(500),DNUM(500)
      COMMON/ONE/ CNN,DNUM,NCOV
C----- INTERPOLATION OF COVARIANCES
      TCOV=dble(NCOV-1)
      R1=dble(DIS)
      IF (R1.LT.TCOV) GO TO 1
      COV=CNN(NCOV)*FACT
      WRITE(21,100) R1
      RETURN
C
      1 IF (R1.GT.0.0001) GO TO 6
      COV=CNN(1)*FACT
      RETURN
C
      6 DO 2 I=1,NCOV
        IF (R1.LT.DNUM(I)) GO TO 3
      2 CONTINUE
      3 I=I-1
      FPINT=R1-DNUM(I)
      FDINT=DNUM(I+1)-DNUM(I)
      COV=CNN(I)+(CNN(I+1)-CNN(I))*FPINT/FDINT
      COV=COV*FACT
      RETURN
C
      100 FORMAT('SEPARATION =',F10.3,' >500 KM COVARIANCE VALUE FOR',
      ' 500 KM USED.')
C
      END

```





```

program fourier2d
character*80 filename
real xdata(361,361),ydata(361,361),xmean,ymean,
> prcnt,delta,cuthi,cutlo,xlag,mincc,maxcc,short,long,
> xcolat,ycolat,xlong,ylong,xgridspc,ygridspc,
> minccin,maxccin,cxlag
integer xpassno,ypassno,file,xcol,xrow,ycol,yrow,
> lhb,cc,npass,imean,head,spass,swind,
> nwind,numfile,nxout,nyout,cnwind,udnwind,
> numcc(10),numlhb(10),numsd(10),numud(10),numrtp(10),
> numderiv(10)
complex xcdata(512,512),ycdata(512,512)
common /rowcol/ xrow,xcol,yrow,ycol
common /fftfft/ nxout,nyout,prcnt,imean,fold,ittypefold
common /lhbflt/ delta,cuthi,cutlo,xlag,npass,nwind
common /ccflt/ mincc,maxcc,minccin,maxccin,cnwind,cxlag
common /reals/ xdata,ydata
common /striking/ angl,ang2,spass,swind,slag
common /udcont/ uddelta,zcon,udxlag,udnwind
common /xyzderiv/ xyzdelta,nth,nway
common /rtp/ azm,xinc,dec
common /comps/ xcdata,ycdata

c-----program description
c
c   fourier2d is an all encompassing fourier analysis program!
c   subroutines include the fft for forward and inverse situations,
c   a bandpass filter which can be adjusted to perform low, high and
c   bandpass filtering of wave numbers, a correlation coefficient
c   filter which zeros out wavenumbers according to correlation
c   coefficients, a strike-dip filter to remove wavelengths in
c   degrees of direction, an upward-downward continuation filter,
c   a derivative filter for any of the three directions and a
c   reduction-to-pole filter for magnetic total field intensity data.
c
c   NOTE: the only data variables absolutely necessary as INPUT are
c   the number of rows and number of columns, the remaining
c   variables; zero,mean,pass-number and eight, are not needed.
c   but, mean can be an OUTPUT if desired.
c   NOTE: fourier2d is for two-dimensional data. if you have a
c   one-dimensional data set then use fourier1d. however,
c   in 1-d i have not yet implemented the continuation,
c   derivative or rtp filters.
c
c   program date: 10 jul 92
c   this code was an extensive modification of an earlier code
c   named fourmat.
c
c   NOTE: because there are 6 filters, there are about forty
c   zillion different combinations of filtering the fft'd
c   data. so, to accomodate all of these, the user must
c   first state how many times to run the filter (lhb,
c   icc, etc) then must state the order where to run each
c   filter (arrays numlhb, numcc, num etc.. hold these
c   user defined positions). note that with this scheme
c   any filter can be run multiple times. be sure to enter
c   only one filter for each position value. the
c   following example should clear things up:
c   say you want to first bandpass filter, then cc
c   filter and then bandpass filter again. then you
c   should set lhb=2 and icc=1. then array numlhb should
c   have the values 1 and 3 (for the first and third positions)
c   and array numcc should only have the value 2 (for the
c   second position.
c
c   write (*,*) 'OUTPUT FILE OF STATISTICS AND INFORMATION'
c   read (*,9990) filename
c   open (25, file=filename,form='formatted')
c
c   write (*,9989)
c9989 format ('1 IF YOU HAVE ONLY ONE FILE TO BE FOURIERED',/
> '2 IF YOU HAVE TWO FILES TO BE COMPARED')
c   read (*,*) numfile
c
c   write (*,9988)
c9988 format ('ENTER THE MAXIMUM NUMBER OF TIMES TO RUN EACH FILTER',/
> 'ENTER 0 TO NOT RUN THE FILTER',/
> 'BANDPASS, CORR.COEFF., STRIKE-DIP, UP/DN CONT., RTP, DERIV')
c   read (*,*) ilhb,icc,isd,iud,irtp,ideriv
c
c   if (ilhb.gt. 0) then
c     write (*,*) 'BANDPASS SECTION:'
c     write (*,*) 'enter placement values in order ie. 2 3 5 '
c     write (*,*) 'do not repeat these values elsewhere'
c     write (*,*) '1=first, 3=third, 5=fifth etc...'
c     read (*,*) (numlhb(i),i=1,ilhb)
c     write (*,9993)
c9993 format ('DELTA.....GRID INTERVAL IN MAP UNITS (1.0 degrees)'/
> 'SHORT.....SHORTEST WAVELENGTH TO BE PASSED'/

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>      '      MUST BE AT LEAST 2*DELTA (2.0 degrees)'/
>      'LONG.....LONGEST WAVELENGTH TO BE PASSED'/
>      '      MUST BE LARGER THAN SHORT'/
>      'NPASS.....-1 TO REJECT WAVELENGTHS BETWEEN SHORT'/
>      '      AND LONG'/
>      '      1 TO PASS WAVELENGTHS BETWEEN SHORT AND'/
>      '      LONG'/
>      '      NOTE : WAVENUMBER = 1/WAVELENGTH AND IS '/
>      '      CALCULATED BY THE PROGRAM'/
>      '      INPUT ORDER IS DELTA SHORT LONG NPASS')
>      read (*,*) delta,short,long,npass
>      write (*,9994)
9994 format (' NWIND..... TYPE OF WINDOW TO APPLY'/
>      '      = 0 GIVES NO WINDOW'/
>      '      = 1 RECTANGULAR WINDOW'/
>      '      = 2 BARTLETT WINDOW (TRIANGULAR)'/
>      '      = 3 HAMMING-TUKEY WINDOW'/
>      '      = 4 PARZEN WINDOW'/
>      '      XLAG.....SMOOTHING PARAMETER FOR WINDOWING IDEAL'/
>      '      FILTER IN SPATIAL DOMAIN (is disabled if'/
>      '      no window was chosen above).'/
>      '      nwind xlag')
>      read (*,*) nwind,xlag
c
>      cuthi=1.0/short
>      cutlo=1.0/long
>      RCUTLO=999999.99
>      IF(CUTLO .GE. 0.0000001 ) RCUTLO= 1.0/CUTLO
>      RCUTHI=1.0/CUTHI
>      WAVLEN=2.0*DELTA
>      FNQ1=1.0/WAVLEN
>      WRITE (25,9987) FNQ1,WAVLEN,CUTLO,RCUTLO,CUTHI,RCUTHI
9987 FORMAT('NYQUIST WAVENUMBER =',F10.5,' CYCLES PER DATA INTERVAL',/
>      'NYQUIST WAVELENGTH = ',F10.5,' LENGTH INTERVALS',/
>      'LOW WAVE# CUTOFF OF IDEAL FILTER = ',F10.5,
>      ' CYCLES PER DATA INTERVAL ',F15.5,
>      ' WAVELENGTH EQUIVALENT',/
>      'HIGH WAVE# CUTOFF OF IDEAL FILTER = ',F10.5,
>      ' CYCLES PER DATA INTERVAL ',F15.5,
>      ' WAVELENGTH EQUIVALENT',//)
>      endif
c
>      if (icc .gt. 0) then
>      if (numfile .ne. 2) then
>      write (*,*) 'you must enter two files to run cc filter'
>      stop
>      endif
>      write (*,*) 'CORRELATION COEFFICIENT SECTION:'
>      write (*,*) 'enter placement values in order ie. 2 3 5 '
>      write (*,*) 'do not repeat these values elsewhere'
>      write (*,*) '1=first, 3=third, 5=fifth etc...'
>      read (*,*) (numcc(i),i=1,icc)
>      write (*,9995)
9995 format ('WHAT IS THE MINIMUM CORR COEF TO BE PASSED:(0.4)'/,
>      'WHAT IS THE MAXIMUM CORR COEF TO BE PASSED:(1.0)'/,
>      'MINIMUM INPUT CC WITHOUT WRITING WARNING',/
>      'MAXIMUM INPUT CC WITHOUT WRITING WARNING',/
>      'CNWIND..... TYPE OF WINDOW TO APPLY'/
>      '      = 0 GIVES NO WINDOW'/
>      '      = 1 RECTANGULAR WINDOW'/
>      '      = 2 BARTLETT WINDOW (TRIANGULAR)'/
>      '      = 3 HAMMING-TUKEY WINDOW'/
>      '      = 4 PARZEN WINDOW'/
>      'CXLAG.....SMOOTHING PARAMETER FOR WINDOWING IDEAL'/
>      '      FILTER IN SPATIAL DOMAIN (is disabled if'/
>      '      no window was chosen above).'/
>      'mincc maxcc minccin maxccin cnwind cxlag')
>      read (*,*) mincc,maxcc,minccin,maxccin,cnwind,cxlag
>      endif
c
>      if (isd .gt. 0) then
>      write (*,*) 'STRIKE-DIP SECTION:'
>      write (*,*) 'enter placement values in order ie. 2 3 5 '
>      write (*,*) 'do not repeat these values elsewhere'
>      write (*,*) '1=first, 3=third, 5=fifth etc...'
>      read (*,*) (numsd(i),i=1,isd)
>      write (*,9986)
9986 format ('ANGLE 1: >= 0.0 AND < ANGLE2',/
>      'ANGLE 2: > ANGLE 1 AND <= 180.0',/
>      '1 TO PASS AZIMUTHS BETWEEN ANGLES',/
>      '-1 TO REJECT AZIMUTHS BETWEEN ANGLES',/
>      'TYPE OF WINDOW TO APPLY TO FILTER',/
>      '0 (NONE), 1 (RECTANGULAR), 2 (TRIANGULAR), 3 (H-T), 4 (PARZEN)',/
>      'LAG VALUE ON SMOOTHING WINDOW (0.1 to 99.9)'/,
>      ' ang1 ang2 spass swind slag')
>      read (*,*) ang1,ang2,spass,swind,slag
>      endif
c
>      if (lud .gt. 0) then
>      write (*,*) 'UP/DOWN CONTINUATION SECTION:'

```

```

        write (*,*) 'enter placement values in order ie. 2 3 5 '
        write (*,*) 'do not repeat these values elsewhere'
        write (*,*) '1=first, 3=third, 5=fifth etc...'
        read (*,*) (numud(1),i=1,iud)
        write (*,9985)
9985 format('udDELTA = GRID INTERVAL IN MAP UNITS (1.0)'/,
> 'ZCON = DISTANCE TO CONTINUE THE DATA SET'//,
> '      IN THE SAME LENGTH UNITS AS DELTA'//,
> '      (1.0 degree = 111 km)'//,
> '      NEGATIVE FOR UPWARD CONTINUATION'//,
> '      POSITIVE FOR DOWNWARD CONTINUATION'//,
> 'udnWIND = TYPE OF WINDOW TO APPLY TO FILTER'//,
> '      0 (NONE), 1 (RECTANGULAR), 2 (TRIANGULAR)'//,
> '      3 (H-T), 4 (PARZEN)'//,
> 'udxLAG = SMOOTHING PARAMETER FOR WINDOWING FILTER'//,
> '      IN SPATIAL DOMAIN. DETERMINES WHAT PERCENTAGE'//,
> '      DATA IS WINDOWED'//,
> '      delta zcon udnwind udxlag')
        read (*,*) uddelta,zcon,udnwind,udxlag
    endif

c
    if (irtp .gt. 0) then
        write (*,*) 'REDUCTION TO POLE SECTION:'
        write (*,*) 'enter placement values in order ie. 2 3 5 '
        write (*,*) 'do not repeat these values elsewhere'
        write (*,*) '1=first, 3=third, 5=fifth etc...'
        read (*,*) (numrtp(1),i=1,irtp)
        write (*,9983)
9983 format ('AZM = AZIMUTH OF Y AXIS MEASURED IN DEGREES'//,
> '      CLOCKWISE FROM TRUE NORTH'//,
> 'DEC = AVERAGE DECLINATION OF THE INPUTTED'//,
> '      ANOMALY DATA'//,
> 'XINC = AVERAGE INCLINATION OF THE INPUTTED'//,
> '      ANOMALY DATA'//,
> 'azm dec xinc')
        read (*,*) azm,dec,xinc
    endif

c
    if (ideriv .gt. 0) then
        write (*,*) 'DERIVATIVE SECTION:'
        write (*,*) 'enter placement values in order ie. 2 3 5 '
        write (*,*) 'do not repeat these values elsewhere'
        write (*,*) '1=first, 3=third, 5=fifth etc...'
        read (*,*) (numderiv(1),i=1,ideriv)
        write (*,9984)
9984 format('xyzDELTA = GRID INTERVAL'//,
> 'NTH = ORDER OF SPATIAL DERIVATIVE TO PERFORM'//,
> '      ON THE DATA'//,
> 'NWAY = DIRECTION IN WHICH TO CALCULATE THE'//,
> '      DERIVATIVE'//,
> '      0 = VERTICAL DERIVATIVE'//,
> '      1 = HORIZONTAL DERIVATIVE IN "X" DIRECTION'//,
> '      2 = HORIZONTAL DERIVATIVE IN "Y" DIRECTION'//,
> 'xyzdelta nth nway')
        read (*,*) xyzdelta,nth,nway
    endif

c
    write (*,9992)
9992 format ('THE FOLLOWING REFERS TO FFT AND IFFT'//,
> 'NUMBER OF COLUMNS AND ROWS OF FFT ARRAY'//,
> 'AT A POWER OF 2: (256 128)(2 16 32 64 128 256 etc)'//,
> 'TYPE OF INPUT ARRAY INDICATES TYPE OF FOLDING TO BE USED'//,
> '      0 IF A POLAR REGION, ie. E AND W EDGES ARE SAME'//,
> '      1 IF A NON-POLAR REGION, ie. E AND W EDGES NOT SAME'//,
> 'PERCENT OF EACH EDGE OF INPUT ARRAY TO'//,
> 'BE FOLDED OUT: (0.1 TO 99.9)'//,
> 'PERCENT OF EACH EDGE OF FOLDED OUT OR NORMAL ARRAY'//,
> 'TO BE SMOOTHED TO ZERO: (0.1 TO 49.9)'//,
> '0 DO NOT ADD MEAN TO IFFT DATA'//,
> '1 ADD MEAN TO IFFT DATA'//,
> 'nxout nyout itypefold fold prcnt imean')
    read (*,*) nxout,nyout,itypefold,fold,prcnt,imean

c
    if (nxout .gt. 512 .or. nyout .gt. 512) then
        write (*,8999) nxout,nyout
8999 format (1x,'SORRY',16,1x,'OR',16,1x,'IS GREATER THAN 512 THE',
> '      SIZE OF ARRAYS SET'// IN THE SOURCE CODE ',
> '      YOU NEED TO ACCESS SOURCE CODE AND MAKE CHANGES')
        stop
    endif

c
c
    write (*,*) 'INPUT FILE 1'
    read (*,9990) filename
9990 format (a80)
    open (10, file=filename,status='old',form='formatted')
    if (numfile .eq. 2) then
        write (*,*) 'INPUT FILE 2'
        read (*,9990) filename
        open (11, file=filename,status='old',form='formatted')

```

```

endif
write (*,*) 'OUTPUT OF FILE 1'
read (*,9990) filename
open (20, file=filename,form='formatted')
if (numfile .eq. 2) then
  write (*,*) 'OUTPUT OF FILE 2'
  read (*,9990) filename
  open (21, file=filename,form='formatted')
endif
c
c
210 continue
read (10,*) xcol
read (10,*) xrow
read (10,*) xcolat
read (10,*) xlong
read (10,*) xgridspc
if (numfile .eq. 2) then
  read (11,*) ycol

read (11,*) yrow

read (11,*) ycolat
  read (11,*) ylong

read (11,*) ygridspc
endif
c
  xpassno=1
  ypassno=2
  do i=1,xrow
    read (10,*) (xdata(j,i),j=1,xcol)
  enddo
  if (numfile .eq. 2) then
    do i=1,yrow
      read (11,*) (ydata(j,i),j=1,ycol)
    enddo
  endif
c
  xmean=0.0
  call forwardft (1,xmean,xpassno)
  ymean=0.0
  if (numfile .eq. 2) call forwardft (2,ymean,ypassno)
c
  itotttime=1lhb+icc+isd+iud+irtp+ideriv
  do i=1,itotttime
    do j=1,1lhb
      if (numlhb(j) .eq. 1) then
        call filter (1)
        if (numfile .eq. 2) call filter (2)
        goto 888
      endif
    enddo
    do j=1,icc
      if (numcc(j) .eq. 1) then
        call correlate(xpassno,ypassno)
        goto 888
      endif
    enddo
    do j=1,isd
      if (numsd(j) .eq. 1) then
        call strkpas(1)
        if (numfile .eq. 2) call strkpas(2)
        goto 888
      endif
    enddo
    do j=1,iud
      if (numud(j) .eq. 1) then
        call upcon(1)
        if (numfile .eq. 2) call upcon(2)
        goto 888
      endif
    enddo
    do j=1,irtp
      if (numrtp(j) .eq. 1) then
        call mag2pol(1)
        if (numfile .eq. 2) call mag2pol(2)
        goto 888
      endif
    enddo
    do j=1,ideriv
      if (numderiv(j) .eq. 1) then
        call deriva(1)
        if (numfile .eq. 2) call deriva(2)
        goto 888
      endif
    enddo
c
888 continue
  enddo

```

```

c
c      call inverseft (1,xmean,xpassno)
      if (numfile .eq. 2) call inverseft (2,ymean,ypassno)
c
      write (20,*) xcol
      write (20,*) xrow
      write (20,*) xcolat
      write (20,*) xlong
      write (20,*) xgridspc
      do i=1,xrow
        write (20,9981) (xdata(j,i),j=1,xcol)
      enddo
9981 format (5(f12.6,1x))
      if (numfile .eq. 2) then
        write (21,*) ycol
        write (21,*) yrow
        write (21,*) ycolat
        write (21,*) ylong

      write (21,*) ygridspc
      do i=1,yrow
        write (21,9981) (ydata(j,i),j=1,ycol)
      enddo
      endif
c
999 continue
close (10)
close (11)
close (20)
close (21)
close (25)
stop
end

c
c
c
      subroutine forwardft (num,mean,passno)
      integer num,xrow,xcol,yrow,ycol,nxout,nyout,passno,
>      row,col
      real xdata(361,361),ydata(361,361),prcnt,mean
      complex xcdata(512,512),ycdata(512,512)
      common /fft1fft/ nxout,nyout,prcnt,imean,fold,itypefold
      common /rowcol/ xrow,xcol,yrow,ycol
      common /reals/ xdata,ydata
      common /comps/ xcdata,ycdata
      COMMON H(512,512)
      DIMENSION X(2,512,512)
      COMPLEX H
      double precision Tsum
      EQUIVALENCE (X(1,1,1),H(1,1))
c
      Tsum=0.D0
      if (num .eq. 1) then
        row=xrow
        col=xcol
        do 50 i=1,row
          do 50 j=1,col
            x(1,j,i) = xdata(j,i)
            tsum=tsum+x(1,j,i)
50          continue
        elseif (num .eq. 2) then
          row=yrow
          col=ycol
          do 80 i=1,row
            do 80 j=1,col
              x(1,j,i) = ydata(j,i)
              tsum=tsum+x(1,j,i)
80          continue
        endif
      endif

c
c*****
c
c      PROGRAM SPA2FRQ
c
c      PROGRAM SPA2FRQ TRANSFORMS AN N X N MATRIX OF SPACE-DOMAIN
c      AMPLITUDES INTO THE N X N MATRIX OF WAVE NUMBER DOMAIN
c      COEFFICIENTS. THE TRANSFORM MAY BE USED BY FIVE
c      IN-CORE PROGRAMS TO PERFORM SPECTRAL OPERATIONS (UPCON,MAGPOL,
c      BANDPASS,STRKPASS,DERIV). FUNCTIONS PERFORMED BY THIS PROGRAM
c      INCLUDE :
c      - REMOVAL OF THE MEAN FROM THE DATA
c      - OPTIONAL WINDOWING OF THE EDGES OF THE DATA SET
c      - PADDING OF THE DATA SET WITH ZEROES TO ACHIEVE NECESSARY
c      SIZE (A POWER OF TWO)
c      - FORWARD TRANSFORM OF THE DATA
c
c.....REQUIRED SUBROUTINES :
c
c      FFT2D, FORK, DATWND

```

```

C
C.....DIMENSIONING REQUIREMENTS :
C
C      X(2,N,N).....WHERE N IS THE NUMBER OF COLUMNS AND ROWS OF THE
C      H(N,N)          OUTPUT TRANSFORMED MATRIX. N MUST BE AN INTEGRAL
C                      POWER OF TWO (2,4,8,16...).
C                      NOTE : DIMENSIONS IN EVERY SUBROUTINE MUST BE
C                      SET EQUAL TO DIMENSIONS IN MAIN PROGRAM.
C
C.....AUTHOR :SUBROUTINES FFT2D AND FORK ARE MODIFIED FROM JON REED,
C              PURDUE UNIVERSITY, DECEMBER 1980.
C              ALL OTHER CODE WRITTEN BY:
C              JEFFREY E. LUCIUS
C              GEOPHYSICAL INTERACTIVE COMPUTING LABORATORY
C              DEPARTMENT OF GEOLOGY AND MINERALOGY
C              THE OHIO STATE UNIVERSITY
C              COLUMBUS, OHIO 43210
C
C              MARCH 25, 1985   (REVISED DEC 5, 1986)
C
C      revised once again for DEC workstations on 6 APR 90 so that
C      that this beast is actually user friendly!
C
C      revised again (judas priest this is getting old) on
C      1 AUG 90 into this present format of all fourier programs
C      combined into this program.
C*****
C
C      IF (2**INT (ALOG (FLOAT (NXOUT)))/ALOG (2.0)+0.01) .NE. NXOUT) THEN
C        WRITE (6,1030)
C        STOP
C      ENDIF
C      IF (2**INT (ALOG (FLOAT (NYOUT)))/ALOG (2.0)+0.01) .NE. NYOUT) THEN
C        WRITE (6,1040)
C        STOP
C      ENDIF
C
C.....CALCULATE AND REMOVE THE MEAN
C
C      nxin=col
C      nyin=row
C      ICOL=nxin
C      IROW=nyin
C      XMEAN1=TSUM/FLOAT (NXIN*NYIN)
C      DO 210 IY=1,NYIN
C        DO 210 IX=1,NXIN
C          X(1,IX,IY)=X(1,IX,IY)-XMEAN1
C210  CONTINUE
C      WRITE (25,1020) XMEAN1
C
C.....WINDOW THE EDGES VIA DATWND
C
C      CALL DATWND (PRCNT,NXIN,NYIN,NXOUT,NYOUT,fold,ittypefold)
C
C.....MATRIX IS NOW ZERO FILLED TO NXOUT BY NYOUT SIZE
C      CALCULATE AND REMOVE THE MEAN INTRODUCED BY TAPERING
C
C      TSUM=0.00
C      DO 214 IY=1,NYOUT
C        DO 214 IX=1,NXOUT
C          TSUM=TSUM+X(1,IX,IY)
C214  CONTINUE
C      XMEAN2=TSUM/FLOAT (NXOUT*NYOUT)
C      DO 215 IY=1,NYOUT
C        DO 215 IX=1,NXOUT
C          X(1,IX,IY)=X(1,IX,IY)-XMEAN2
C215  CONTINUE
C      WRITE (25,1020) XMEAN2
C      XMEAN=XMEAN2+XMEAN1
C      WRITE (25,1080) XMEAN
C      write (25,*) passno,xmean1,xmean2,xmean
C
C.....TRANSFORM DATA TO THE WAVENUMBER DOMAIN
C
C      NX=NXOUT
C      NY=NYOUT
C      CALL FFT2D (NX,NY,-1)
C
C      mean=xmean
C      if (num .eq. 1) then
C        do 500 iy=1,ny
C          do 500 ix=1,nx
C            xcdata(ix,iy) = h(ix,iy)
C500    continue
C      elseif (num .eq. 2) then
C        do 580 iy=1,ny
C          do 580 ix=1,nx
C            ycdata(ix,iy) = h(ix,iy)
C580    continue
C      endif

```

```

C
C      return
C
1020 FORMAT('MEAN REMOVED ',F15.7)
1030 FORMAT(1H , 'NXOUT MUST BE A POWER OF 2: SPA2FRQ FATAL')
1040 FORMAT(1H , 'NYOUT MUST BE A POWER OF 2: SPA2FRQ FATAL')
1080 FORMAT('TOTAL MEAN REMOVED ',F15.7)
C
C      END
C
C*****
C
C      SUBROUTINE FFT2D (NX,NY,NSIGN)
C
C*****
C
C      "FFT2D" PERFORMS BOTH A FORWARD OR INVERSE FAST FOURIER
C      TRANSFORM. "FFT2D" IS THE DRIVER THAT PASSES THE CORRECT VECTORS
C      TO "FORK" WHICH PERFORMS THE ACTUAL TRANSFORMING.
C      THE DIMENSIONING OF "H" MUST BE THE SAME AS IN THE MAIN PROGRAM
C
C      "NSIGN" = DIRECTION OF DESIRED TRANSFORMATION
C      +1 INVERSE TRANSFORM (FREQUENCY TO SPATIAL)
C      -1 FORWARD TRANSFORM (SPATIAL TO FREQUENCY)
C*****
C
C      COMMON H(512,512)
C      COMMON CTEMP(512)
C      COMPLEX H,CTEMP
C
C      SIGNI=FLOAT(NSIGN)
C      IF (IABS(NSIGN).NE.1) THEN
C        WRITE(6,105)
C        STOP
C      ENDIF
C
C      C.....OPERATE BY ROWS
C
C      DO 101 IY=1,NY
C101    CALL FORK (NX,H(1,IY),SIGNI)
C
C      C.....OPERATE BY COLUMNS
C
C      DO 104 IX=1,NX
C      DO 102 IY=1,NY
C102    CTEMP(IY)=H(IX,IY)
C      CALL FORK (NY,CTEMP,SIGNI)
C      DO 103 IY=1,NY
C103    H(IX,IY)=CTEMP(IY)
C104    CONTINUE
C
C      RETURN
C
C105    FORMAT(5X,"NSIGN" MUST EQUAL +1 OR -1 FOR "FFT2D", FATAL')
C
C      END
C
C*****
C
C      SUBROUTINE FORK (LXX,CX,SIGNI)
C
C*****
C
C      FAST FOURIER TRANSFORM, MODIFIED FROM CLAERBOUT, J.F., FUNDAMENTAL
C      OF GEOPHYSICAL DATA PROCESSING, MCGRAW-HILL, 1976
C      FORK USES COOLEY-TUKEY ALGORITHM.
C
C      "CX" = DATA VECTOR TO BE TRANSFORMED
C      "LXX" = LENGTH OF DATA VECTOR "CX" TO BE TRANSFORMED,
C      MUST BE A POWER OF 2 (LXX=2**INTEGER)
C      "SIGNI"= DIRECTION OF DESIRED TRANSFORMATION
C      +1. INVERSE TRANSFORM (FREQUENCY TO SPATIAL)
C      -1. FORWARD TRANSFORM (SPATIAL TO FREQUENCY)
C
C      NORMALIZATION PERFORMED BY DIVIDING BY
C      DATA LENGTH UPON THE FORWARD TRANSFORM.
C*****
C
C      COMPLEX CX(LXX),CW,CTEMP,CON2
C
C      LX=LXX
C      LXH=LX/2
C      J=1
C      DO 103 I=1,LX
C      IF (I.LT.J) THEN
C        CTEMP=CX(J)
C        CX(J)=CX(I)
C        CX(I)=CTEMP
C      ENDIF
C      M=LXH

```



```

102   IF (J.GT.M) THEN
      J=J-M
      M=M/2
      IF (M.GE.1) GO TO 102
    ENDIF
      J=J+M
103   CONTINUE
      L=1
104   ISTEP=2*L
      CON2=(0.0,3.14159265)/FLOAT(L)*SIGNI
      DO 105 M=1,L
        CW=CEXP(CON2*FLOAT(M-1))
        DO 105 I=M,LX,ISTEP
          CTEMP=CW*CX(I+L)
          CX(I+L)=CX(I)-CTEMP
105   CX(I)=CX(I)+CTEMP
      L=ISTEP
      IF (L.LT.LX) GO TO 104
      IF (SIGNI.GT.0.0) RETURN
      SC=1./FLOAT(LX)
C
      DO 106 I=1,LX
106   CX(I)=CX(I)*SC
C
      RETURN
      END
C
C*****
C
      SUBROUTINE DATWND (PRCNT,NX11,NY11,NX,NY,fold,ittypefold)
C*****
C
C "DATWND" MULTIPLIES THE INPUT F(1,X,Y) BY A HALF BELL OF A HAMMIN-
C   TUKEY WINDOW ON ALL EDGES AND ZEROS OUT THE REMAINDER OF THE
C   (NX,NY) ARRAY.
C
C "PRCNT" =PERCENTAGE OF DATA TO BE ALTERED IN SMOOTHING TO ZERO
C   0.0 .LT. "PRCNT" .LE. 50.0
C
C   update 2 feb 91
C   datwnd has been considerably improved such that now the subroutine
C   performs three (count them, three !!) functions. one; a percentage
C   of the input matrix can be folded out. two; after folding out,
C   a new percentage of the folded out matrix (or regular data if
C   folding was not performed) can be smoothed to zero. three; the
C   manipulated data is centered within zeros to finish filling the
C   matrix to nx by ny size. because the actual data is now centered
C   within the transformed array, it is necessary to use the
C   do loops in subroutine inverseft to correctly extract the actual
C   data
C*****
C
      dimension holdme(512,512)
      COMMON F(2,512,512)
C
      nx1=nx11
      ny1=ny11
C
C----- fold out the data based on percentage
C
      if (fold.gt.0.0 .and. fold.lt.100.0) then
C
        KX=Int(fold*FLOAT(NX1)/100.0+0.5)
        KY=Int(fold*FLOAT(NY1)/100.0+0.5)
        if (kx+nx1 .gt. nx) kx=(nx-nx1)/2
        if (ky+ny1 .gt. ny) ky=(ny-ny1)/2
        do j=1,ny1
          do i=1,nx1
            holdme(i,j)=f(1,i,j)
          enddo
        enddo
C----- fold out the columns in each row:
C   if ittypefold is 1 then the data is considered to
C   to be a rectangular style of projection where
C   the east and west edges of the data are not
C   covering the same geographic region. therefore,
C   the folding out of data along a row is symmetric
C   with respect to the individual edge.
C
      if (itypefold .eq. 1 ) then
        do j=1,ny1
          do i=1,nx1+kx+kx
            if (i.le.kx) f(1,i,j)=holdme(kx-i+1,j)
            if (i.gt.kx .and. i.le.(kx+nx1)) f(1,i,j)=holdme(i-kx,j)
            if (i.gt.(kx+nx1)) f(1,i,j)=holdme((2*nx1+kx+1-i),j)
          enddo
        enddo
C

```

```

c----- if itypefold is 0 then the array is considered to
c         be a polar style of projection where the east and
c         west edges are covering the same geographic area.
c         therefore, the folding along each row is actually
c         adding the western edge of data to the eastern
c         edge and eastern data to western edge.
c
c         elseif (itypefold .eq. 0) then
c             do j=1,ny1
c                 do i=1,nx1+kx+kx
c                     if (i.le.kx) f(1,i,j)=holdme(nx1+i-kx,j)
c                     if (i.gt.kx .and. i.le.(kx+nx1)) f(1,i,j)=holdme(i-kx,j)
c                     if (i.gt.(kx+nx1)) f(1,i,j)=holdme((i-nx1-kx),j)
c                 enddo
c             enddo
c         endif
c
c         if (ny1 .eq. 1) go to 333
c         do j=1,ny1
c             do i=1,nx1+kx+kx
c                 holdme(i,j)=f(1,i,j)
c             enddo
c         enddo
c----- fold out the rows in each column
c         do i=1,nx1+kx+kx
c             do j=1,ny1+ky+ky
c                 if (j.le.ky) f(1,i,j)=holdme(i,ky-j+1)
c                 if (j.gt.ky .and. j.le.(ky+ny1)) f(1,i,j)=holdme(i,j-ky)
c                 if (j.gt.(ky+ny1)) f(1,i,j)=holdme(i,(2*ny1+ky+1-j))
c             enddo
c             ny1=ny1+2*ky
c             nx1=nx1+2*kx
c         enddo
c
c         if (prcnt.gt.0.0 .and. prcnt.lt.50.0) then
c             KX=IFIX (PRCNT*FLOAT (NX1)/100.0+0.5)
c             KY=IFIX (PRCNT*FLOAT (NY1)/100.0+0.5)
c
c         C.....APPLY WINDOW TO COLUMNS
c         C
c             IF (NY1.NE.1 .AND. KY.NE.0) THEN
c                 RKYPI= 3.14159265/FLOAT (KY)
c                 DO 10 IY=1,KY
c                     FACTOR=0.5*(1.0+COS (FLOAT (KY-IY+1)*RKYPI))
c                     IYY=NY1-IY+1
c                     DO 10 IX=1,NX1
c                         F(1,IX,IY) = F(1,IX,IY) * FACTOR
c                     F(1,IX,IYY)= F(1,IX,IY)* FACTOR
c                 10
c             ENDIF
c
c         C.....APPLY WINDOW TO ROWS
c         C
c             IF (KX.NE.0) THEN
c                 RKXPI= 3.14159265/FLOAT (KX)
c                 DO 30 IX=1,KX
c                     FACTOR=0.5*(1.0+COS (FLOAT (KX-IX+1)*RKXPI))
c                     IXX=NX1-IX+1
c                     DO 30 IY=1,NY1
c                         F(1,IX,IY)=F(1,IX,IY) * FACTOR
c                     F(1,IXX,IY) =F(1,IXX,IY)* FACTOR
c                 30
c             ENDIF
c
c         WRITE(25,150) KX, KY
c         write (25,*) kx,ky
c         endif
c
c         C.....center and ZERO OUT REMAINDER OF ARRAY
c         C
c             nxhalf=(nx-nx1)/2
c             nyhalf=(ny-ny1)/2
c             do i=1,nx1
c                 do j=1,ny1
c                     holdme(i,j)=f(1,i,j)
c                 enddo
c             enddo
c             do i=1,nxhalf
c                 do j=1,ny
c                     f(1,i,j)=0.0
c                 enddo
c             enddo
c             do i=nxhalf+1,nxhalf+nx1
c                 do j=1,ny
c                     if (j .le. nyhalf) f(1,i,j)=0.0
c                     if (j.gt.nyhalf .and. j.le.nyhalf+ny1)
c                         f(1,i,j)=holdme(i-nxhalf,j-nyhalf)
c                     if (j .gt. nyhalf+ny1) f(1,i,j)=0.0
c                 enddo
c             enddo
c             do i=nxhalf+nx1+1,nx

```



```

        CALL WINDOW (NX,NY,XLAG,NWIND)
        CALL FFT2D (NX,NY,-1)
    ENDIF
ENDIF
C
C.....WRITE FILTER (WAVENUMBER DOMAIN) ONTO UNIT 30 IF IOFIL = 1
C
C    IF (IOFIL.EQ.1) THEN
C        WRITE (30,*) NX,NY, IZERO,XMEAN
C        DO 200 IY=1,NY
C            WRITE (30,*) (H(IX,IY),IX=1,NX)
C200    CONTINUE
C        WRITE(6,1040) NX,NY
C    ENDIF
C
    if (num .eq. 1) then
        do 500 i=1,row
            do 500 j=1,col
                xcdata(j,i) = xcdata(j,i)*h(j,i)
500        continue
    elseif (num .eq. 2) then
        do 580 i=1,row
            do 580 j=1,col
                ycdata(j,i) = ycdata(j,i)*h(j,i)
580        continue
    endif
C
    return
end
C
C*****
C
    SUBROUTINE BNDPAS (CCUTLO,CCUTHI,NPASS,DELTA,NX,NY)
C*****
C
C    "BNDPAS" CALCULATES TWO QUADRANTS OF THE WAVE# RESPONSE OF
C    AN IDEAL BANDPASS FILTER OF A (NX,NY) MATRIX.
C    ARRAY "H" MUST BE DIMENSIONED THE SAME AS IN THE MAIN PROGRAM
C
C    "CCUTLO"   LOWEST WAVE# TO BE PASSED, GE 0.0
C    "CCUTHI"   HIGHEST WAVE# TO BE PASSED, LE NYQUIST
C    "NPASS"    SWITCHES EITHER A PASS OR REJECTION BETWEEN
C               "CUTLO" & "CUTHI"
C               --1 REJECT WAVENUMBERS BETWEEN THE 2 WAVENUMBERS
C               = 1 PASS WAVENUMBERS BETWEEN THE 2 WAVENUMBERS
C    "DELTA"    DATA GRID INTERVAL, IN MAP UNITS
C    "NX"       NUMBER OF ROWS (POWER OF 2 GE "ICOL", 16,32,ETC)
C    "NY"       NUMBER OF COLUMNS (POWER OF 2 GE "IROW", 16,32,ETC)
C*****
C
    COMMON H(512,512)
    COMPLEX H,ZERO,ONE
    DIMENSION A(2)
    DATA A/4HPASS,4HCUT /
C
    CUTHI=CCUTHI
    CUTLO=CCUTLO
    RCUTLO=999999.99
    IF (CUTLO.GE. 0.0000001 ) RCUTLO= 1.0/CUTLO
    RCUTHI=1.0/CUTHI
    WAVLEN=2.0*DELTA
    FNQ1=1.0/WAVLEN
    WRITE (25,112) FNQ1,WAVLEN,CUTLO,RCUTLO,CUTHI,RCUTHI,NPASS
C
    IF (IABS(NPASS).NE.1) THEN
        WRITE (6,151)
        STOP
    ENDIF
    IF (CUTHI.GT.FNQ1.OR.CUTHI.LE.CUTLO.OR.CUTLO.LT.0.0) THEN
        WRITE (6,151)
        STOP
    ENDIF
C
    NXX=NX+2
    NX2=(NX/2)+1
    NY2=(NY/2)+1
    ANY2=FLOAT(NY2)
    ZERO = (0.0,0.0)
    ONE = (1.0,0.0)
    WAY = A(1)
C
    IF (NPASS.NE.1) THEN
        ZERO = (1.0,0.0)
        ONE = (0.0,0.0)
        WAY = A(2)
    ENDIF
C
    RHIY2 = (FNQ1/(ANY2*CUTHI))**2

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      NHIY = CUTHI*WAVLEN*ANY2+1.0
      NHIY=AMINO(NHIY,NY2)
      CLOWX=FLOAT(NX2)*WAVLEN*CUTLO
      CHIX =FLOAT(NX2)*WAVLEN*CUTHI
C
      IF (CUTLO.LE.0.000001) THEN
C
      WRITE(6,152) WAY
      RLOWY2=0.0
      NLOWY=0
      ELSE
      IF (FNQ1-CUTHI.LT.0.000001) THEN
C
      WRITE(6,153) WAY
      RLOWY2=(FNQ1/(ANY2*CUTLO))**2
      NLOWY=CUTLO*WAVLEN*ANY2+1.0
      ELSE
C
      WRITE(6,154)
      RLOWY2=(FNQ1/(ANY2*CUTLO))**2
      NLOWY=CUTLO*WAVLEN*ANY2+1.0
      ENDIF
      ENDIF
C
C
C....."ZERO" OUT THE PART OF ARRAY TO BE ALTERED
C
      DO 35 IY=1,NY2
      DO 35 IX=1,NX
      H(IX,IY) = ZERO
35  CONTINUE
C
C.....OPERATE ON ROWS WHERE SOME WAVENUMBERS ARE .LE. CUTLO
C
      IF (NLOWY.NE.0) THEN
      MINS=1
      MAXS=NX2
      IF (NLOWY.EQ.1) THEN
      IF (CUTLO.GT.0.000001) MINS=NX2*CUTLO*WAVLEN+2.0001
      IF (FNQ1-CUTHI.GT.0.000001) MAXS=NX2*CUTHI*WAVLEN+1.0001
      ENDIF
      DO 102 IY=1,NLOWY
      Y2=FLOAT(IY-1)**2
      MINX=MINS
      IF (CUTLO.GT.0.000001) THEN
      MINX=CLOWX*SQRT(1.0-Y2*RLOWY2)+2.0001
      ENDIF
      MAXX=MAXS
      IF (FNQ1-CUTHI.GE.0.000001) THEN
      MAXX=CHIX*SQRT(1.0-Y2*RHIY2)+1.0001
      ENDIF
      IF (MINX.EQ.1) THEN
      H(1,IY)= ONE
      MINX=MINX+1
      ENDIF
      IF (MINX.LE.MAXX) THEN
      DO 150 IX=MINX,MAXX
      H(NXX-IX,IY)= ONE
150  H(IX,IY)= ONE
      ENDIF
102  CONTINUE
      ENDIF
C
C.....OPERATE ON ROWS WHERE ALL WAVENUMBERS ARE .GT. CUTLO
C
      IF (NHIY.NE.NY2) THEN
      LL=NLOWY+1
      DO 200 IY=LL,NHIY
      Y2=FLOAT(IY-1)**2
      MAXX=CHIX*SQRT(1.0-Y2*RHIY2)+1.0001
      H(1,IY)= ONE
      IF (MAXX.NE.1) THEN
      DO 180 IX=2,MAXX
      H(NXX-IX,IY)= ONE
180  H(IX,IY)=ONE
      ENDIF
200  CONTINUE
      ELSE
      IF (NLOWY+1.GT.NY2) RETURN
      LL=NLOWY+1
      DO 215 IY=LL,NY2
      DO 215 IX=1,NX
      H(IX,IY)= ONE
215  CONTINUE
      ENDIF
C
      RETURN
C
112  FORMAT(/1X,'NYQUIST WAVENUMBER =',F10.5,'CYCLES PER DATA INTERVAL'
> /1X,'NYQUIST WAVELENGTH = ',F10.5,' LENGTH INTERVALS'/
> 1X,'LOW WAVE# CUTOFF OF IDEAL FILTER = ',F10.5,
> ' CYCLES PER DATA INTERVAL',3X,F15.5,' WAVELENGTH EQUIVALENT'/
> 1X,'HIGH WAVE# CUTOFF OF IDEAL FILTER = ',F10.5,

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>          ' CYCLES PER DATA INTERVAL',3X,F15.5,
>          ' WAVELENGTH EQUIVALENT',/1X,'NPASS= ',I1//)
151 FORMAT(5X,'IMPOSSIBLE FILTER CONSTRUCTION IS SPECIFIED. FATAL')
152 FORMAT(1H-,'LOW ',A4,' FILTER IS BEING CONSTRUCTED IN "BNDPAS"'/)
153 FORMAT(1H-,'HIGH ',A4,' FILTER IS BEING CONSTRUCTED IN "BNDPAS"'/)
154 FORMAT(1H-,'BAND PASS FILTER IS BEING CONSTRUCTED IN "BNDPAS"'/)
C
      END
C
C
C*****
C
      SUBROUTINE STORE (NNX,NNY)
C
      COMMON H(512,512)
      COMPLEX H
C
      IF (NNY.EQ.1) RETURN
      NX=NNX
      NY=NNY
      NXH=NX/2+1
      NXX=NX+2
      NYH=NY/2+2
      NYL=NYH-1
      DO 15 IY=NYH,NY
        NYL=NYL-1
        H(1,IY)=H(1,NYL)
        DO 10 IX=2,NX
          H(IX,IY)=CONJG (H (NXX-IX,NYL) )
10        CONTINUE
        H (NXH,IY) =H (NXH,NYL)
15      CONTINUE
C
      RETURN
      END
C
C*****
C
      SUBROUTINE WINDOW (NX,NY,XLAG,NWIND)
C
C*****
C "WINDOW" PERFORMS 2-DIMENSION WINDOWING OVER A 4 QUAD. DATA ARRAY *
C EACH QUAD. IS SEPERATELY WINDOWED. THE 1.0 COEFFICIENT IS ALWAYS *
C THE OUTER MOST CORNER OF THE ARRAY. *
C FOR ONE DIMENSIONAL WINDOW, LET NY=1 *
C *
C "NX" = NUMBER OF COLUMNS IN DATA MATRIX *
C "NY" = NUMBER OF ROWS IN DATA MATRIX *
C "XLAG" = SMOOTHING PARAMETER FOR WINDOWING IDEAL FILTER IN SPATIAL *
C DOMAIN. DETERMINES WHAT PERCENTAGE OF DATA IS WINDOWED *
C (NX*XLAG/100.0) THE REMAINDER IS SET TO 0.0. I.E. THE *
C SMALLER "XLAG" THE SMOOTHER THE WINDOWING. *
C "XLAG" MUST BE .GT. 0.0 .AND. LE. 100.0 FOR WINDOWING *
C VALUES OUTSIDE OF THIS RESULTS IN NO WINDOWING *
C THE SMALLER THE "XLAG" THE SMOOTHER THE FILTER. *
C *
C "NWIND" = TYPE OF WINDOW TO APPLY *
C -0 GIVES NO WINDOW *
C -1 gives a rectangular window *
C -2 GIVES BARTLETT WINDOW (TRIANGLE WINDOW) *
C -3 GIVES HAMMING-TUKEY WINDOW *
C -4 GIVES PARZEN WINDOW *
C *
C *****
C
      COMMON H(512,512)
      COMPLEX H
C
      IF (XLAG.LE.0.0 .OR. XLAG.GT.100.0) THEN
        WRITE(6,50) XLAG
        RETURN
      ENDIF
C
      LAG=FLOAT (NX) *XLAG/200.0+0.5
      LAG=AMAX0 (LAG,2)
      PI=3.14159265
      NXX=NX+2
      NYY=NY+2
      NX2=(NX/2)+1
      XNXR=FLOAT (NX2)
      XNX=1.0/FLOAT (NX2)
      NY2=(NY/2)+1
      IF (NY.EQ.1) NY2=1
      YNY=1.0/FLOAT (NY2)
C
      RADIUS=FLOAT (LAG) *XNX
      RADI=1.0/RADIUS
      RAD2= RADIUS*RADIUS
      NRAD=FLOAT (NY2) *RADIUS+1.0001
C

```

```

C.....APPLY RECTANGULAR WINDOW TO FILTER
C
C   IF (NWIND.EQ.1) THEN
C
C       IF (NRAD.NE.0) THEN
C           MAX=RADIUS*XNXR+1.0001
C
C           IF (MAX.EQ.0) THEN
C               H(1,1)=(0.0,0.0)
C               MAX=MAX+1
C           ENDIF
C
C           LL=MAX+1
C           DO 155 II=LL,NX2
C               H(NXX-II,1)=(0.0,0.0)
155      H(II,1)=(0.0,0.0)
C           ENDIF
C
C           IF (NRAD.NE.1.AND.NRAD.NE.0) THEN
C               DO 102 IY=2,NRAD
C                   IYY=NYI-IY
C                   YLEN2=(FLOAT(IY-1)*YNY)**2
C                   MAX=SQRT(RAD2-YLEN2)*XNXR+1.0001
C
C                   IF (MAX.EQ.0) THEN
C                       H(1,IY)=(0.0,0.0)
C                       H(IY,IYY)=(0.0,0.0)
C                       MAX=MAX+1
C                   ENDIF
C
C                   LL=MAX+1
C                   DO 105 II=LL,NX2
C                       H(NXX-II,IY)=(0.0,0.0)
C                       H(II,IY)=(0.0,0.0)
C                       H(NXX-II,IYY)=(0.0,0.0)
105      H(II,IYY)=(0.0,0.0)
102      CONTINUE
C                   ENDIF
C
C                   WRITE(25,660) XLAG,LAG
C                   IF (NRAD.EQ.NY2) RETURN
C                   LL=NRAD+1
C                   DO 108 I=LL,NY2
C                       IYY=NYI-I
C                       H(1,I)=(0.0,0.0)
C                       H(1,IYY)=(0.0,0.0)
C                       DO 109 J=2,NX2
C                           H(J,I)=(0.0,0.0)
C                           H(NXX-J,I)=(0.0,0.0)
C                           H(J,IYY)=(0.0,0.0)
109      H(NXX-J,IYY)=(0.0,0.0)
108      CONTINUE
C
C.....APPLY BARTLETT WINDOW TO FILTER
C
C   ELSEIF (NWIND.EQ.2) THEN
C
C       IF (NRAD.NE.0) THEN
C           MAX=RADIUS*XNXR+1.0001
C
C           IF (MAX.GE.2) THEN
C               DO 253 LL=2,MAX
C                   XI=FLOAT(LL-1)*XNX
C                   FACTOR=1.0-XI*RADI
C                   H(LL,1)=H(LL,1)*FACTOR
C                   MX=NXX-LL
253      H(MX,1)=H(MX,1)*FACTOR
C               ENDIF
C
C               LL=MAX+1
C               DO 255 II=LL,NX2
C                   H(NXX-II,1)=(0.0,0.0)
255      H(II,1)=(0.0,0.0)
C               ENDIF
C
C               IF (NRAD.NE.1.AND.NRAD.NE.0) THEN
C                   DO 202 IY=2,NRAD
C                       IYY=NYI-IY
C                       XI=FLOAT(IY-1)*YNY
C                       YLEN2=XI*XI
C                       MAX=SQRT(RAD2-YLEN2)*XNXR+1.0001
C                       FACTOR=1.0-XI*RADI
C                       H(1,IY)=H(1,IY)*FACTOR
C                       H(1,IY)=H(1,IY)*FACTOR
C
C                       IF (MAX.GE.2) THEN
C                           DO 203 LL=2,MAX
C                               XI=SQRT((FLOAT(LL-1)*XNX)**2+YLEN2)
C                               FACTOR=1.0-XI*RADI
C                               H(LL,IYY)=H(LL,IYY)*FACTOR
C                               H(LL,IY)=H(LL,IY)*FACTOR

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```

      MX=NX-LL
      H(MX,IYY)=H(MX,IYY)*FACTOR
203      H(MX,IY)=H(MX,IY)*FACTOR
      ENDIF
C
      LL=MAX+1
      DO 205 II=LL,NX2
        H(NXX-II,IYY)=(0.0,0.0)
        H(II,IYY)=(0.0,0.0)
        H(NXX-II,IY)=(0.0,0.0)
205      H(II,IY)=(0.0,0.0)
202      CONTINUE
      ENDIF
C
C      WRITE(25,661) XLAG,LAG
      IF(NRAD.EQ.NY2) RETURN
      LL=NRAD+1
      DO 208 I=LL,NY2
        IYY=NYY-I
        H(1,I)=(0.0,0.0)
        H(1,IYY)=(0.0,0.0)
        DO 209 J=2,NX2
          H(J,IYY)=(0.0,0.0)
          H(NXX-J,IYY)=(0.0,0.0)
          H(J,I)=(0.0,0.0)
209      H(NXX-J,I)=(0.0,0.0)
208      CONTINUE
C
C.....APPLY HAMMING-TUKEY WINDOW TO FILTER
C
      ELSEIF(NWIND.EQ.3) THEN
C
      IF(NRAD.NE.0) THEN
        PIRADI=PI*RADI
        MAX=RADIUS*XNXR+1.0001
C
        IF(MAX.GE.2) THEN
          DO 353 LL=2,MAX
            XI=FLOAT(LL-1)*XNX
            FACTOR=0.5*(1.0+COS(PIRADI*XI))
            H(LL,1)=H(LL,1)*FACTOR
            MX=NX-LL
353      H(MX,1)=H(MX,1)*FACTOR
          ENDIF
C
          LL=MAX+1
          DO 355 II=LL,NX2
            H(NXX-II,1)=(0.0,0.0)
355      H(II,1)=(0.0,0.0)
          ENDIF
C
          IF(NRAD.NE.1.AND.NRAD.NE.0) THEN
            DO 302 IY=2,NRAD
              XI=FLOAT(IY-1)*YNY
              YLEN2= XI*XI
              IYY=NYY-IY
              MAX=SQRT(RAD2-YLEN2)*XNXR+1.0001
              FACTOR=0.5*(1.0+COS(PIRADI*XI))
              H(1,IYY)=H(1,IYY)*FACTOR
              H(1,IY)=H(1,IY)*FACTOR
C
              IF(MAX.GE.2) THEN
                DO 303 LL=2,MAX
                  XI=SQRT((FLOAT(LL-1)*XNX)**2+YLEN2)
                  FACTOR=0.5*(1.0+COS(PIRADI*XI))
                  H(LL,IYY)=H(LL,IYY)*FACTOR
                  H(LL,IY)=H(LL,IY)*FACTOR
                  MX=NX-LL
                  H(MX,IYY)=H(MX,IYY)*FACTOR
303      H(MX,IY)=H(MX,IY)*FACTOR
                ENDIF
C
                LL=MAX+1
                DO 305 II=LL,NX2
                  H(NXX-II,IYY)=(0.0,0.0)
                  H(II,IYY)=(0.0,0.0)
                  H(NXX-II,IY)=(0.0,0.0)
305      H(II,IY)=(0.0,0.0)
302      CONTINUE
                ENDIF
C
                WRITE(25,662) XLAG,LAG
                IF(NRAD.EQ.NY2) RETURN
                LL=NRAD+1
                DO 308 I=LL,NY2
                  IYY=NYY-I
                  H(1,I)=(0.0,0.0)
                  H(1,IYY)=(0.0,0.0)
                  DO 309 J=2,NX2
                    H(J,IYY)=(0.0,0.0)

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```

      H(NXX-J,IYY)=(0.0,0.0)
      H(J,I)=(0.0,0.0)
309      H(NXX-J,I)=(0.0,0.0)
308      CONTINUE
C
C.....APPLY PARZEN WINDOW TO FILTER
C
      ELSEIF(NWIND.EQ.4) THEN
C
      IF(NRAD.NE.0) THEN
        MAX=RADIUS*XNXR+1.0001
        N2RAD=FLOAT(NY2)*RADIUS*0.5+1.0001
        MAX2=SQRT(RAD2/4.0)*XNXR+1.0001
        FACTOR=1.0-6.0*((XI*RADI)**2-(XI*RADI)**3)
        H(1,1)=H(1,1)*FACTOR
C
        IF(MAX2.GE.2) THEN
          DO 453 LL=2,MAX2
            XI=FLOAT(LL-1)*XNX
            FACTOR=1.0-6.0*((XI*RADI)**2-(XI*RADI)**3)
            H(LL,1)=H(LL,1)*FACTOR
            MX=NXX-LL
453          H(MX,1)=H(MX,1)*FACTOR
          ENDIF
C
          KOUNT=MAX2+1
          DO 457 LL=KOUNT,MAX
            XI=FLOAT(LL-1)*XNX
            FACTOR=2.0*(1.0-(XI*RADI))**3
            H(LL,1)=H(LL,1)*FACTOR
            MX=NXX-LL
457          H(MX,1)=H(MX,1)*FACTOR
            LL=MAX+1
            DO 455 II=LL,NX2
              H(NXX-II,1)=(0.0,0.0)
455            H(II,1)=(0.0,0.0)
          ENDIF
C
          IF(NRAD.NE.1.AND.NRAD.NE.0) THEN
            DO 402 IY=2,NRAD
              IYY=NYI-IY
              XI=FLOAT(IY-1)*YNY
              YLEN2= XI*XI
              MAX=SQRT(RAD2-YLEN2)*XNXR+1.0001
              N2RAD=FLOAT(NY2)*RADIUS*0.5+1.0001
C
              IF(IY.GT.N2RAD) THEN
                KOUNT=2
                FACTOR=2.0*(1.0-(XI*RADI))**3
                H(1,IYY)=H(1,IYY)*FACTOR
                H(1,IY)=H(1,IY)*FACTOR
              ELSE
                MAX2=SQRT(RAD2/4.0-YLEN2)*XNXR+1.0001
                FACTOR=1.0-6.0*((XI*RADI)**2-(XI*RADI)**3)
                H(1,IYY)=H(1,IYY)*FACTOR
                H(1,IY)=H(1,IY)*FACTOR
C
                IF(MAX2.GE.2) THEN
                  DO 403 LL=2,MAX2
                    XI=SQRT((FLOAT(LL-1)*XNX)**2+YLEN2)
                    FACTOR=1.0-6.0*((XI*RADI)**2-(XI*RADI)**3)
                    H(LL,IYY)=H(LL,IYY)*FACTOR
                    H(LL,IY)=H(LL,IY)*FACTOR
                    MX=NXX-LL
403                  H(MX,IYY)=H(MX,IYY)*FACTOR
                    H(MX,IY)=H(MX,IY)*FACTOR
                  ENDIF
C
                  KOUNT=MAX2+1
                  ENDIF
C
                  DO 407 LL=KOUNT,MAX
                    XI=SQRT((FLOAT(LL-1)*XNX)**2+YLEN2)
                    FACTOR=2.0*(1.0-(XI*RADI))**3
                    H(LL,IYY)=H(LL,IYY)*FACTOR
                    H(LL,IY)=H(LL,IY)*FACTOR
                    MX=NXX-LL
407                  H(MX,IYY)=H(MX,IYY)*FACTOR
                    H(MX,IY)=H(MX,IY)*FACTOR
                    LL=MAX+1
                    DO 405 II=LL,NX2
                      H(NXX-II,IYY)=(0.0,0.0)
                      H(II,IYY)=(0.0,0.0)
                      H(NXX-II,IY)=(0.0,0.0)
405                    H(II,IY)=(0.0,0.0)
402                  CONTINUE
                ENDIF
C
              WRITE(25,663) XLAG,LAG
              IF(NRAD.EQ.NY2) RETURN

```

```

        LL=NRAD+1
        DO 408 I=LL,NY2
            IYY=NYI-I
            H(1,I)=(0.0,0.0)
            H(1,IYY)=(0.0,0.0)
            DO 409 J=2,NX2
                H(J,IYY)=(0.0,0.0)
                H(NXX-J,IYY)=(0.0,0.0)
                H(J,I)=(0.0,0.0)
            H(NXX-J,I)=(0.0,0.0)
409      H(NXX-J,I)=(0.0,0.0)
408      CONTINUE
C
C.....DO NOT APPLY A WINDOW TO FILTER
C
        ELSEIF(NWIND.EQ.0) THEN
C          WRITE(25,664)
C        ENDIF
C
        RETURN
C
50      FORMAT(3X,'INPUTTED XLAG OF ',F5.2,' EXCEEDS PERMISSIBLE ',
>          'RANGE OF.GT. 0.0 .AND. .LE. 100.0, NO WINDOWING PERFORMED')
660     FORMAT ('RECTANGULAR WINDOW USED XLAG= ',F7.3,4X,'LAG= ',I5)
661     FORMAT ('BARTLETT WINDOW USED XLAG= ',F7.3,4X,'LAG= ',I5)
662     FORMAT ('HAMMING-TUKEY WINDOW USED XLAG= ',F7.3,4X,'LAG= ',I5)
663     FORMAT ('PARZEN WINDOW USED XLAG= ',F7.3,4X,'LAG= ',I5)
664     FORMAT ('NO WINDOWING HAS BEEN APPLIED ; XLAG= ',F7.3)
C
        END
C
C
        subroutine correlate(xpassno,ypassno)
        integer xrow,xcol,yrow,ycol,nxout,nyout,
>          xpassno,ypassno,zeroCnt(512,512),cnwind
        real mincc,maxcc,ccwinout,prcnt,
>          pctpr3,pctpr4,minccin,maxccin,cxlag
        complex h(512,512),power5,power6,totpwr
        COMPLEX X(512,512),Y(512,512),zero,
>          POWER1,POWER2,POWER3,POWER4,XPOWER,TPOWER
        REAL CCOEF,CCIN,CCOUT
        DATA ZERO/(0.000000,0.000000)/
        common /rowcol/ xrow,xcol,yrow,ycol
        common /comps/ x,y
        common /ccflt/ mincc,maxcc,minccin,maxccin,cnwind,cxlag
        common /fft1fft/ nxout,nyout,prcnt,imean,fold,ittypefold
        common h
C
C----- subroutine description
C
C      correlate finds the correlation coefficient between each
C      wavenumber component of the two input arrays.  each cc is
C      normalized to range between -1.0 through 0.0 to 1.0.  the
C      cc is the cosine of the phase angle difference between
C      two wavenumber components.
C
C      revised 4 aug 90:  i've added the windowing functions
C      available from the bandpassing subroutines to this cc-
C      filter.  try them if you like.
C
C      updates 1 feb 91:  change calculation of correlation
C      coefficient from a summation based formula to the cosine of
C      the phase angle difference.
C
C
        nx=nxout
        ny=nyout
C
        if (xcol.ne.ycol .or. xrow.ne.yrow ) then
            write (*,*) 'NO MATCH BETWEEN ROW OR COLUMN'
            write (*,*) 'CORRELATION COEF MAY NOT BE CORRECT'
            write (*,*) 'PASSNUMBERS=',xpassno,ypassno
            write (*,*) 'FILE 1: ROW COL =',xrow,xcol
            write (*,*) 'FILE 2: ROW COL =',yrow,ycol
        endif
C
        pi=3.141592654
        twopi=6.283185307
        POWER1=ZERO
        POWER2=ZERO
        POWER3=ZERO
        POWER4=ZERO
        XPOWER=ZERO
        TPPOWER=ZERO
C
        DO 110 j=1,NY
            DO 120 i=1,NX
C----- zeroCnt array is a flagging array used to
C          set the windowing array h to equal
C          (0.0,0.0) or (1.0,0.0).  a little inspection
C          of subroutine BNDPAS will help illuminate

```

```

C                                     the principle.
C      zeroct(i,j)=1
C
C SUM THE POWERS & CROSS PRODUCTS OF THE INPUT MAPS.
C
C      POWER1=POWER1+(X(I,J)*CONJG(X(I,J)))
C      POWER2=POWER2+(Y(I,J)*CONJG(Y(I,J)))
C      XPOWER=XPOWER+(X(I,J)*CONJG(Y(I,J)))
C
C----- xrad is the phase angle of the x array wavenumber and
C      yrad is the phase angle of the y array wavenumber. the
C      cosine of the minimum phase difference is the correlation
C      of the two wavenumbers. to find the minimum phase difference
C      it is necessary to adjust xrad or yrad with integer values
C      of pi. so....do not change the order of the if statements !!
C
C      xrad=atan(aimag(x(i,j))/(real(x(i,j))))
C      if (real(x(i,j)).lt.0.0) xrad=xrad+pi
C      if (aimag(x(i,j)).lt.0.0) xrad=xrad+twopi
C      yrad=atan(aimag(y(i,j))/(real(y(i,j))))
C      if (real(y(i,j)).lt.0.0) yrad=yrad+pi
C      if (aimag(y(i,j)).lt.0.0) yrad=yrad+twopi
C      delrad=abs(xrad-yrad)
C      ccof=cos(delrad)
C
C      IF (CCOEF .GT. maxcc .or. CCOEF .LT. mincc) THEN
C          X(I,J)=ZERO
C          Y(I,J)=ZERO
C          zeroct(i,j)=0
C      ENDIF
C
C SUM THE POWERS & CROSS PRODUCTS FOR THE OUTPUT MAPS.
C
C      POWER3=POWER3+(X(I,J)*CONJG(X(I,J)))
C      POWER4=POWER4+(Y(I,J)*CONJG(Y(I,J)))
C      TPOWER=TPOWER+(X(I,J)*CONJG(Y(I,J)))
C
C 120 CONTINUE
C 110 CONTINUE
C
C CALCULATE THE C.C. FOR THE INPUT MAPS.
C
C      if (power1 .eq. zero .or. power2 .eq. zero) then
C          write (*,*) 'power1 =',power1,xpassno
C          write (*,*) 'power2 =',power2,ypassno
C          ccin=9999.9
C      else
C          CCIN=REAL(XPOWER/SQRT(POWER1*POWER2))
C      endif
C
C CALCULATE THE C.C. FOR THE OUTPUT MAPS.
C
C      if (power3 .eq. zero .or. power4 .eq. zero) then
C          write (*,*) 'power3 =',power3,xpassno
C          write (*,*) 'power4 =',power4,ypassno
C          ccout=9999.9
C      else
C          CCOUT=REAL(TPOWER/SQRT(POWER3*POWER4))
C      endif
C
C CALCULATE THE PERCENTAGE OF THE POWER RETAINED IN THE FILTERED
C MAPS.
C
C      if (power1 .eq. zero .or. power2 .eq. zero) then
C          pctpr1=9999.9
C          pctpr2=9999.9
C      else
C          PCTPR1=(POWER3/POWER1)*100.0
C          PCTPR2=(POWER4/POWER2)*100.0
C      endif
C
C WRITE THE C.C. FOR THE INPUT & OUTPUT MAPS TO FILE 6.
C
C      WRITE (6,444) CCIN
C      WRITE (6,555) CCOUT
C
C WRITE THE POWER PERCENTAGES TO FILE 6.
C
C      WRITE (6,666) PCTPR1,PCTPR2
C 444 FORMAT (' ','THE CORRELATION COEFFICIENT BETWEEN THE INPUT '
C      * ,',MAPS IS ',F6.3)
C 555 FORMAT (' ','THE CORRELATION COEFFICIENT BETWEEN THE OUTPUT '
C      * ,',MAPS IS ',F6.3)
C 666 FORMAT (' ','THE PERCENTAGE OF THE TOTAL POWER IN MAP ONE',
C      * ' PASSED IS',F7.3,'%',/, ' THE PERCENTAGE OF THE TOTAL POWER',
C      * ' IN MAP TWO PASSED IS',F7.3,'%')
C
C
C      write (25,888) xpassno,ypassno,ccin,ccout,pctpr1,pctpr2
C 888 format (2i6,4f10.3)
C      if (ccin .lt. minccin) write (*,*)xpassno,ypassno,ccin,' <min'

```

```

      if (ccin .gt. maxccin) write (*,*) xpassno, ypassno, ccin, ' >max'
c----- the following if statement controls
c         the windowing functions for smoothing
c         the output arrays and calculates a new
c         output correlation coefficient and
c         percents of power retained in the
c         windowed arrays because
c         the data will change slightly with
c         windowing
c
c      write (*,*) '1 = zeroCnt, 0 != zeroCnt'
c      read (*,*) i
c      if (i .eq. 1) then
c         write (50,*) nx
c         write (50,*) ny
c         do i=1,ny
c            write (50,9970) (zeroCnt(j,i),j=1,nx)
c         enddo
c 9970      format (20(13,1x))
c      endif
c
c      if (cnwind .ge. 1 .and. cnwind .le. 4) then
c         power5=zero
c         power6=zero
c         totpwr=zero
c         do 300 i=1,ny
c            do 300 j=1,nx
c               h(j,i) = (1.0,0.0)
c               if (zeroCnt(j,i) .eq. 0) h(j,i) = (0.0,0.0)
c 300      continue
c         call store (nx,ny)
c         call fft2d (nx,ny,1)
c         call window (nx,ny,cxlag,cnwind)
c         call fft2d (nx,ny,-1)
c         do 330 iy=1,ny
c            do 330 ix=1,nx
c               x(ix,iy) = x(ix,iy)*h(ix,iy)
c               y(ix,iy) = y(ix,iy)*h(ix,iy)
c               power5=power5+(x(ix,iy)*conjg(x(ix,iy)))
c               power6=power6+(y(ix,iy)*conjg(y(ix,iy)))
c               totpwr=totalpwr+(x(ix,iy)*conjg(y(ix,iy)))
c 330      continue
c         if (power5 .eq. zero .or. power6 .eq. zero) then
c            write (*,*) 'power5 =',power5,xpassno
c            write (*,*) 'power6 =',power6,ypassno
c            ccwinout=9999.9
c            go to 340
c         endif
c         if (power1 .eq. zero .or. power2 .eq. zero) then
c            pctpr3=9999.9
c            pctpr4=9999.9
c            go to 340
c         endif
c         ccwinout=real(totpwr/sqrt(power5*power6))
c         pctpr3=(power5/power1)*100.0
c         pctpr4=(power6/power2)*100.0
c 340      continue
c 888      write (25,888) xpassno, ypassno, ccin, ccwinout, pctpr3, pctpr4
c         format (216,4f10.3)
c      endif
c
c      return
c      end
c
c
c      subroutine inverseft (num,mean,passno)
c      integer num,xrow,xcol,yrow,ycol,row,col,passno
c      real xdata(361,361),ydata(361,361),mean
c      complex xcdata(512,512),ycdata(512,512)
c      common /rowcol/ xrow,xcol,yrow,ycol
c      common /reals/ xdata,ydata
c      common /comps/ xcdata,ycdata
c      common /fftifft/ nxout,nyout,prcnt,lmean,fold,ittypefold
c      common H(512,512)
c      DIMENSION X(2,512,512),holdme(361,361)
c      COMPLEX H
c      EQUIVALENCE (X(1,1,1),H(1,1))
c
c      if (num .eq. 1) then
c         ny=nyout
c         nx=nxout
c         row=xrow
c         col=xcol
c         do 50 j=1,ny
c            do 50 i=1,nx
c               h(i,j) = xcdata(i,j)
c 50      continue
c      elseif (num .eq. 2) then

```

```

      ny=nyout
      nx=nxout
      row=yrow
      col=ycol
      do 80 j=1,ny
        do 80 i=1,nx
          h(i,j) = ycdata(i,j)
80      continue
    endif

C*****
C
C      PROGRAM FRQ2SPA
C
C      PROGRAM FRQ2SPA INVERSE TRANSFORMS AN N X N MATRIX OF WAVENUMBER
C      DOMAIN COEFFICIENTS INTO THE N X N MATRIX OF SPACE DOMAIN
C      AMPLITUDES.  FUNCTIONS PERFORMED BY THIS PROGRAM INCLUDE :
C      - INVERSE TRANSFORM OF THE DATA
C      - RESTORING THE MEAN TO THE DATA
C      - CALCULATION OF SPACE DOMAIN MAXIMUM AND MINIMUM AMPLITUDES
C
C.....REQUIRED SUBROUTINES :
C
C      FFT2D, FORK
C
C.....DIMENSIONING REQUIREMENTS :
C
C      X(2,N,N).....WHERE N IS THE NUMBER OF COLUMNS AND ROWS OF THE
C      H(N,N)      OUTPUT TRANSFORMED MATRIX. N MUST BE AN INTEGRAL
C                  POWER OF TWO (2,4,8,256...).
C                  NOTE : DIMENSIONS IN EVERY SUBROUTINE MUST BE
C                  SET EQUAL TO DIMENSIONS IN MAIN PROGRAM.
C
C.....AUTHOR : JEFF LUCIUS
C              DEPARTMENT OF GEOLOGY AND MINERALOGY
C              OHIO STATE UNIVERSITY, DECEMBER 1984.
C
C      revised: 8 AUG 90
C      updated: 2 feb 91
C              added do loops that find the data portion of the
C              zero centered inverse transformed data.  a look at
C              subroutine datwnd will help figure this out.
C*****
C
C.....INVERSE TRANSFORM DATA TO THE SPACE DOMAIN
C
C      irow=row
C      icol=col
C
C      CALL FFT2D (NX,NY,+1)
C
C      nxhalf=(nx-icol)/2
C      nyhalf=(ny-irow)/2
C      do i=nxhalf+1,nxhalf+icol
C        do j=nyhalf+1,nyhalf+irow
C          holdme(i-nxhalf,j-nyhalf)=x(1,i,j)
C        enddo
C      enddo
C
C      total=0.0
C      DO 210 J=1,Irow
C        DO 210 I=1,Icol
C          x(1,i,j)=holdme(i,j)
C
C      total=total+x(1,i,j)
C210  CONTINUE
C      xmean=total/float(icol*irow)
C      IF (IMEAN.EQ. 1) THEN
C        do 215 j=1,irow
C          do 215 i=1,icol
C            x(1,i,j)=x(1,i,j)+mean
C215  continue
C      ENDIF
C
C      XMIN= 1.0E20
C      XMAX=-1.0E20
C      DO 220 J=1,irow
C        if (num.eq. 1) then
C          do i=1,icol
C            xdata(i,j) = x(1,i,j)
C          enddo
C        elseif (num.eq. 2) then
C          do i=1,icol
C            ydata(i,j) = x(1,i,j)
C          enddo
C        endif
C      DO 220 I=1,icol
C        XMIN=AMIN1(XMIN,X(1,I,J))

```

```

      XMAX=AMAX1(XMAX,X(1,I,J))
      IF (XMAX.EQ.X(1,I,J)) THEN
        IMAX=I
        JMAX=J
      ENDIF
      IF (XMIN.EQ.X(1,I,J)) THEN
        IMIN=I
        JMIN=J
      ENDIF
220  CONTINUE
c    WRITE (25,1020) XMAX,JMAX,IMAX,XMIN,JMIN,IMIN,xmean,passno
c    write (25,9980) passno,xmean,xmax,jmax,imax,xmin,jmin,imin
9980 format (15,2x,f13.5,2x,f13.5,2x,i4,2x,i4,f13.5,2x,i4,2x,i4)
c
1020 FORMAT('MAXIMUM OF IFFT = ',E15.7,' AT (' ,I3,',',I3,')'//,
> 'MINIMUM = ',E15.7,' AT (' ,I3,',',I3,')'//,
> 'MEAN AFTER IFFT = ',e15.7,' FOR PASS',i6,/)
c
      return
      END
c
c
c
c
      subroutine STRKPAS (num)
      integer num,xrow,xcol,yrow,ycol,spass,swind,
>      imean,nxout,nyout,row,col
      real prcnt,slag
      complex xcdata(512,512),ycdata(512,512)
      common /fftifft/ nxout,nyout,prcnt,imean,fold,ittypefold
      common /comps/ xcdata,ycdata
      common /striking/ angl,ang2,spass,swind,slag
      COMMON H(512,512)
      COMPLEX H
c
      if (num .eq. 1) then
        row=nyout
        col=nxout
        nx=nxout
        ny=nyout
      elseif (num .eq. 2) then
        row=nyout
        col=nxout
        nx=nxout
        ny=nyout
      endif
c *****
c "STRIKE" PERFORMS A STRIKE SENSITIVE FILTERING (FAN FILTER)
c ON UNIFORMLY GRIDDED ONE OR TWO DIMENSIONAL DATA SETS.
c
c "sPASS" = CONTROLS IF DATA IS TO BE PASSED OR REJECTED BETWEEN
c "ANG1" AND "ANG2".
c = 1 PASS AZIMUTHS BETWEEN ANGLES "ANG1" & "ANG2"
c --1 REJECT AZIMUTHS BETWEEN ANGLES "ANG1" & "ANG2"
c "ANG1" = SMALLEST ANGLE, GE 0.0 .AND. LT "ANG2"
c "ANG2" = LARGEST ANGLE, GT "ANG1" .AND. LE 180.00
c
c
c updates and revisions:
c
c 23 dec 91; added this strike pass routine to the fourier
c program. required removal of write statements
c *****
c
c CALL STRIKE (ANG1,ANG2,SPASS,NX,NY)
c
c----- CREATE SMOOTHED FILTER
c
c IF (sLAG.gt.0.0 .and. sLAG.lt.100.0) then
c   if (swind.gt.0 .and. swind.le.4) then
c     CALL FFT2D (NX,NY,1)
c     CALL WINDOW (NX,NY,sLAG,swind)
c     CALL FFT2D (NX,NY,-1)
c   endif
c endif
c
c----- SET UP TO WRITE 30 if desired
c
c DO 356 IY=1,NY
c   WRITE (30) (H(IX,IY),IX=1,NX)
c 356 CONTINUE
c
c----- ACCESS TRANSFORM OF DATA & MULTIPLY *FILTER (CONVOLVING)
c
c if (num .eq. 1) then
c   do 500 i=1,row
c     do 500 j=1,col
c       xcdata(j,i) = xcdata(j,i)*h(j,i)

```

```

500      continue
      elseif (num .eq. 2) then
        do 580 i=1,row
          do 580 j=1,col
            ycdata(j,i) = ycdata(j,i)*h(j,i)
580      continue
      endif
c
      return
      end
c
c
c      SUBROUTINE STRIKE (AANG1,AANG2,NNPASS,NNX,NNY)
c
      COMPLEX H,ZERO,ONE
      COMMON H(512,512)
      DATA DG2RAD,DG90 /0.017453293,1.570796327/
c
c *****
c "STRIKE" CREATES A STRIKE SENSITIVE FILTER (FAN FILTER) *
c FOR 2 QUADRANTS OF THE (NX,NY) MATRIX *
c ARRAY "H" MUST BE DIMENSIONED THE SAME AS IN THE MAIN PROGRAM *
c *
c (ANGLES ARE MEASURED IN DEGREES CLOCKWISE FROM NORTH) *
c "ANG1 " = SMALLEST ANGLE, GE 0.0 .AND. LT ANG2 *
c "ANG2 " = LARGEST ANGLE, GT ANG1 .AND. LE 180.0 *
c "NPASS" = STATES IF DATA IS PASSED OR REJECTED BETWEEN THE 2 ANGLES *
c --1 REJECT AZIMUTHS BETWEEN ANGLES "ANG1" & "ANG2" *
c = 1 PASS AZIMUTHS BETWEEN ANGLES "ANG1" & "ANG2" *
c "NX" = NUMBER OF ROWS (POWER OF 2 GE "NX1", 16,32,ETC) MAX=128 *
c "NY" = NUMBER OF ROWS (POWER OF 2 GE "NY1", 16,32,ETC) MAX=128 *
c *****
c
      NX=NNX
      NY=NNY
      ANG1 = AANG1
      ANG2 = AANG2
      NPASS = NNPASS
c
      IF (ANG1.LT.ANG2 .AND. ANG1.GE.0.0 .AND. ANG2.LE.180.0) GOTO 109
      WRITE(6,125)
125      FORMAT(5X, 'ILLEGAL SPECIFICATION OF STRIKE ANGLES, FATAL')
      STOP
109      CONTINUE
c
      NX2=NX/2+1
      NY2=NY/2+1
      NX1=NX+1
      NXX=NX+2
      NYY=NY+2
      XY=FLOAT(NX2)/FLOAT(NY2)
c
      ZERO= (0.0,0.0)
      ONE = (1.0,0.0)
      IF (NPASS.NE.-1) GOTO 160
      ZERO=(1.0,0.0)
      ONE = (0.0,0.0)
160      CONTINUE
c
c *****
c 'ZERO' OUT ARRAY
c *****
c
      DO 15 IY=1,NY
        DO 15 IX=1,NX
15          H(IX,IY)=ZERO
c
c *****
c COMPUTE PARAMETERS FOR SOUTHWEST QUADRANT OF MATRIX
c *****
c
      IF (ANG2.GE.90.0) GOTO 20
      IYMAX=0
      GOTO 200
c
20      IF (ANG1.GT.90.0) GOTO 114
      A1=0.0
      TA1=0.0
      IYMAX=NY2
      ADA1=1.5
      GOTO 113
114      CONTINUE
      A1=ATAN(TAN((ANG1-90.0)*DG2RAD)*XY)
      TA1=TAN(A1)
      IYMAX=FLOAT(NX2)/TA1+1.0
      IYMAX=AMINO(IYMAX,NY2)
      ADA1=1.0
113      CONTINUE
c

```

```

        IF (ANG2.LT.180.0) GOTO 115
        A2=DG90
        TA2=0.0
        ADA2=FLOAT(NX2)+0.5
        GOTO 116
115 CONTINUE
        A2=ATAN(TAN((ANG2-90.0)*DG2RAD)*XY)
        TA2=TAN(A2)
        ADA2=1.0
116 CONTINUE
C
200 IF (ANG1.LE.90.0) GOTO 25
        IYMAXX=0
        GOTO 300
C
C *****
C      COMPUTE PARAMETERS FOR SOUTHEAST QUADRANT OF MATRIX
C *****
C
25 IF (ANG1.GT.0.0) GOTO 45
        A1=0.0
        TTA1=1.0E20
        ADDA1=FLOAT(NX2)-2.5
        GOTO 60
45 IF (ANG1.NE.90.0) GOTO 55
        A1=0.0
        A2=0.0
        TTA1=0.0
        TTA2=0.0
        ADDA1= 0.0
        ADDA2= 0.0
        IYMAXX=NY2
        GOTO 122
55 A1=ATAN(TAN(ANG1*DG2RAD)/XY)
        TTA1= 1.0/TAN(A1)
        ADDA1=1.0
C
60 IF (ANG2.LT.90.0) GOTO 121
        IYMAXX=NY2
        TTA2=0.0
        ADDA2= 0.0
        GOTO 122
121 CONTINUE
        A2=ATAN(TAN(ANG2*DG2RAD)/XY)
        TTA2= 1.0/TAN(A2)
        ADDA2=1.0
        IYMAXX= ABS(FLOAT(NX2)/TTA2+1.5)
        IYMAXX=AMIN0(IYMAXX,NY2)
122 CONTINUE
C
C *****
C      CALCULATE THE FILTER COEFFICIENTS
C *****
C
300      NYMAX=AMAX0(IYMAX,IYMAXX)
        DO 50 IY=1,NYMAX
            Y=FLOAT(IY-1)
C
C *****
C      DEFINE SOUTHWEST QUADRANT
C *****
C
        IF (IYMAX.LT.IY) GOTO 30
        MIN=Y*TA1+ADA1
        MAX=Y*TA2+ADA2
        MAX=AMIN0(MAX,NX2)
C
        IF (MIN.GT.MAX) GOTO 30
        DO 75 IX=MIN,MAX
            H(IX,IY)=ONE
75
C
C *****
C      DEFINE SOUTHEAST QUADRANT
C *****
C
30      IF (IYMAXX.LT.IY) GOTO 35
        MIN=(NX1-(Y*TTA2))+ADDA2
        MIN=AMIN0(MIN,NX)
        MAX=(NX1-(Y*TTA1))+ADDA1
        MAX=AMAX0(MAX,NX2+1)
C
        IF (MAX.GT.NX) GO TO 35
        DO 275 IX=MAX,MIN
            H(IX,IY)=ONE
275
C
C *****
C      USE ANTI-SYMMETRY TO DEFINE QUADRANTS # 2 & 3
C *****
C
35      IF (IY.EQ.1 .OR. IY.EQ.NY2) GOTO 50

```



```

      IYY=NYI-IY
      DO 40 IX=2,NX
40      H(NXX-IX,IYY)=H(IX,IY)
      H(1,IYY)=H(1,IY)
50  CONTINUE
      H(1,1)=(1.0,0.0)
C
      RETURN
      END
C
C
C
C
      subroutine UPCON (num)
      integer num,npass,imean,nwind,nxout,nyout,udnwind,
      >      row,col
      complex xcdat(512,512),ycdat(512,512)
      common /fftifft/ nxout,nyout,prcnt,imean,fold,ittypefold
      common /comps/ xcdat,ycdat
      common /udcont/ delta,zcon,udxlag,udnwind
      COMMON H(512,512)
      COMPLEX H
C
      if (num .eq. 1) then
        row=nyout
        col=nxout
        nx=nxout
        ny=nyout
      elseif (num .eq. 2) then
        row=nyout
        col=nxout
        nx=nxout
        ny=nyout
      endif
C
C *****
C
C "UPCON" PERFORMS UPWARD OR DOWNWARD CONTINUATION ON UNIFORMLY
C GRIDDED ONE OR TWO DIMENSIONAL DATA SETS.
C *****
C
C CREATE CONTINUATION FILTER
C
      CALL CONTIN (DELTA,ZCON,NX,NY)
      CALL STORE (NX,NY)
C
      smooth the continuation filter
C
      IF(udxLAG.gt.0.0 .and. udxLAG.le.100.0) then
        if (udnwind .le. 4 .and. udnwind .gt. 0) then
          CALL FFT2D (NX,NY,1)
          CALL WINDOW (NX,NY,udxLAG,udnwind)
          CALL FFT2D (NX,NY,-1)
        endif
      endif
C
C ACCESS TRANSFORM OF DATA & MULTIPLE *FILTER (CONVOLVING)
C
      if (num .eq. 1) then
        do 500 i=1,row
          do 500 j=1,col
            xcdat(j,i) = xcdat(j,i)*h(j,i)
500      continue
      elseif (num .eq. 2) then
        do 580 i=1,row
          do 580 j=1,col
            ycdat(j,i) = ycdat(j,i)*h(j,i)
580      continue
      endif
C
      return
      end
C
C
C
C
      SUBROUTINE CONTIN (DELTA,ZCON,NX,NY)
      COMMON H(512,512)
      COMPLEX H
C
C *****
C
C "CONTIN" COMPUTES TWO QUADRANTS (NX/2+1 BY NY) OF AN IDEA
C UPWARD OF DOWNWARD CONTINUATION FILTER DIMENSIONED "NX" BY "NY".
C FOR ONE DIMENSION LET NY=1.
C ARRAY "H" MUST BE DIMENSIONED THE SAME AS IN THE MAIN PROGRAM
C
C "DELTA"= GRID INTERVAL IN LENGTH UNITS
C "ZCON" = THE DEPTH OR HEIGHT AT WHICH CONTINUATION IS DESIRED.
C (IN THE SAME LENGTH UNITS AS "DELTA", I.E. MILES,KM)

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```

C      IF "ZCON" IS NEGATIVE FILTER WILL BE UPWARD CONTINUATION      *
C      IF "ZCON" IS POSITIVE FILTER WILL BE DOWNWARD CONTINUATION  *
C                                                                    *
C*****
C      PI2Z= 3.14159265 *ZCON/DELTA
C      NXX=NX+2
C      NX2=NX/2+1
C      RNK2=1.0/FLOAT(NX2)
C      NY2=NY/2+1
C      RNY2=1.0/FLOAT(NY2)
C
C      DO 101 IY=1,NY2
C        CON1=(FLOAT(IY-1)*RNY2)**2
C        S=SQRT(CON1)
C        X1=EXP(S*PI2Z)
C        H(1,IY)=CMPLX(X1,0.0)
C        DO 101 IX=2,NX2
C          S=SQRT((FLOAT(IX-1)*RNK2)**2+CON1)
C          X1=EXP(S*PI2Z)
C          H(IX,IY)=CMPLX(X1,0.0)
C          H(NXX-IX,IY)=H(IX,IY)
101 CONTINUE
C      H(1,1)=(1.0,0.0)
C
C      RETURN
C      END
C
C
C
C
C      subroutine DERIVA (num)
C      integer num,npass,imean,nwind,nxout,nyout,
C      >      row,col
C      complex xcdata(512,512),ycdata(512,512)
C      common /fftifft/ nxout,nyout,prcnt,imean,fold,ittypefold
C      common /comps/ xcdata,ycdata
C      common /xyzderiv/ delta,nth,nway
C      COMMON H(512,512)
C      COMPLEX H
C
C      if (num .eq. 1) then
C        row=nyout
C        col=nxout
C        nx=nxout
C        ny=nyout
C      elseif (num .eq. 2) then
C        row=nyout
C        col=nxout
C        nx=nxout
C        ny=nyout
C      endif
C
C*****
C      "DERIVA" CALCULATES THE "NTH" DERIVATIVE IN THE WAVE#      *
C      DOMAIN OF UNIFORMLY GRIDDED ONE OR TWO DIMENSIONAL DATA SETS. *
C*****
C
C      CREATE DERIVATIVE FILTER
C
C      CALL DERIV(NX,NY,NTH,NWAY,DELTA)
C
C      ACCESS TRANSFORM OF DATA & MULTIPLE *FILTER (CONVOLVING)
C
C      if (num .eq. 1) then
C        do 500 i=1,row
C          do 500 j=1,col
C            xcdata(j,i) = xcdata(j,i)*h(j,i)
500      continue
C      elseif (num .eq. 2) then
C        do 580 i=1,row
C          do 580 j=1,col
C            ycdata(j,i) = ycdata(j,i)*h(j,i)
580      continue
C      endif
C
C      return
C      end
C
C      SUBROUTINE DERIV(NNX,NNY,NNTH,NWAY,DELTA)
C      COMMON C(512,512)
C      COMPLEX C,CON,CON2,CON3
C*****
C      "DERIV" CALCULATES THE VALUES OF 2 QUADRANTS FOR THE      *
C      "NTH" DERIVATIVE OF A (NX,NY) MATRIX. THESE VALUES ARE TO *

```

```

C BE MULTIPLIED BY THE WAVE# SPECTRUM OF THE GIVEN FIELD.          *
C FOR A 1 DIMENSIONAL ARRAY SET "NY"-1                             *
C ARRAY "C" MUST BE DIMENSIONED THE SAME AS IN THE MAIN PROGRAM.    *
C                                                                      *
C "NNTH" = THE ORDER OF DERIVATIVE DESIRED                          *
C "NWAY" = THE DIRECTION THE DERIVATIVE IS TO TAKEN                 *
C          0 VERTICAL DIRECTION                                     *
C          1 HORIZONTAL DIRECTION (X)                               *
C          2 HORIZONTAL DIRECTION (Y)                               *
C "DELTA" = GRID INTERVAL IN LENGTH UNITS                           *
C                                                                      *
C*****
C
C      NX=NNX
C      NY=NNY
C      NTH=NNTH
C      NX2=NX+2
C      NX2=NX/2+1
C      NYY=NY+2
C      NY2=NY/2+1
C      CON=(6.2831853,0.0)
C      IF (NWAY.GE.1) CON=(0.0,6.2831853)
C      RNKDEL=1.0/(FLOAT(NX)*DELTA)
C      RNYDEL=1.0/(FLOAT(NY)*DELTA)
C
C *****
C      TAKE VERTICAL DERIVATIVE IN WAVE# DOMAIN
C *****
C
C      IF (nway .eq. 0) THEN
C      DO 105 IX=2,NX2
C          FX2=(FLOAT(IX-1)*RNKDEL)
C          C(IX,1)=(CON*FX2)**NTH
105  C(NXX-IX,1) = (CON*FX2)**NTH
C      C(1,1) = (0.0,0.0)
C
C      DO 110 IY=2,NY2
C          IYY=NYY-IY
C          FY2=(FLOAT(IY-1)*RNYDEL)
C          C(1,IYY)=(CON*FY2)**NTH
C          C(1,IY) = (CON*FY2)**NTH
C          FY2=FY2**2
C      DO 110 IX=2,NX2
C          FX2=(FLOAT(IX-1)*RNKDEL)**2
C          S=SQRT(FX2+FY2)
C          CON2=(CON*S)**NTH
C          C(NXX-IX,IYY) = CON2
C          C(IX,IYY) = CON2
C          C(NXX-IX,IY) = CON2
110  C(IX,IY) = CON2
C      RETURN
C
C *****
C      TAKE HORIZONTAL(Y) DERIVATIVE IN WAVE# DOMAIN
C *****
C
C      ELSEIF (nway .eq. 2) THEN
C      DO 205 IX=1,NX
C          C(IX,1) = (0.0,0.0)
205  C
C      DO 210 IY=2,NY2
C          IYY=NYY-IY
C          CON2=(FLOAT(IY-1)*RNYDEL*CON)**NTH
C          CON3=CONJG(CON2)
C          DO 210 IX=1,NX
C              C(IX,IYY) = CON3
210  C(IX,IY) = CON2
C      RETURN
C
C *****
C      TAKE HORIZONTAL(X) DERIVATIVE IN WAVE# DOMAIN
C *****
C
C      ELSEIF (nway .eq. 1) THEN
C      DO 305 IY=1,NY2
C          C(1,NYY-IY) = (0.0,0.0)
305  C(1,IY) = (0.0,0.0)
C
C      DO 310 IX=2,NX2
C          IXX=NX-IX
C          CON2=(FLOAT(IX-1)*RNKDEL*CON)**NTH
C          CON3=CONJG(CON2)
C          C(IXX,1) = CON3
C          C(IX,1) = CON2
C      DO 310 IY=2,NY2
C          C(IXX,NYY-IY)=CON3
C          C(IXX,IY) =CON3
C          C(IX,NYY-IY)=CON2
310  C(IX,IY) =CON2
C      RETURN

```

```

    else
      write (*,*) 'nway is not equal to 0,1 or 2'
      stop
    endif
  end
end
c
c
c
c
c
      subroutine MAG2POL (num)
      integer num, npass, imean, nwind, nxout, nyout,
>      row, col
      complex xcdat(512,512), ycdat(512,512)
      common /fftifft/ nxout, nyout, prcnt, imean, fold, itypefold
      common /comps/ xcdat, ycdat
      common /rtp/ azm, xinc, dec
      common H(512,512)
      complex H
c
      if (num .eq. 1) then
        row=nyout
        col=nxout
        nx=nxout
        ny=nyout
      elseif (num .eq. 2) then
        row=nyout
        col=nxout
        nx=nxout
        ny=nyout
      endif
c
c *****
c
c      "MAG2POL" APPROXIMATELY CALCULATES THE CORRESPONDING MAGNETIC *
c      ANOMALY MAP DUE TO AN EARTH'S FIELD VECTOR OF 0.0 DECLINATION, *
c      AND 90.0 INCLINATION FROM AN INPUTTED MAGNETIC ANOMALY MAP WITH *
c      A KNOWN FIELD VECTOR.
c *****
c
c      DEC=DEC+AZM
c      CALL MAGPOL(XINC,DEC,NX,NY)
c
c      ACCESS TRANSFORM OF DATA & MULTIPLE *FILTER (CONVOLVING)
c
c      if (num .eq. 1) then
c        do 500 i=1,row
c          do 500 j=1,col
c            xcdat(j,i) = xcdat(j,i)*h(j,i)
500      continue
c      elseif (num .eq. 2) then
c        do 580 i=1,row
c          do 580 j=1,col
c            ycdat(j,i) = ycdat(j,i)*h(j,i)
580      continue
c      endif
c
c      return
c      end
c
c
c
c
c
      SUBROUTINE MAGPOL(AINC,DDEC,NX,NY)
      common X(512,512)
      complex X,CONA,CONB
c
c *****
c
c      "MAGPOL" CREATES A WAVE# REDUCTION-TO-MAGNETIC-POLE FILTER *
c      ONTO THE ARRAY "X" IN BLANK COMMON *
c      THE DIMENSIONS OF THE ARRAY "X" MUST BE IDENTICAL TO THAT IN *
c      THE MAIN PROGRAM.
c *****
c
c      "AINC"    THE AVERAGE MAGNETIC INCLINATION OF THE AREA IN DEGREES. *
c      "DDEC"    THE AVERAGE MAGNETIC DECLINATION OF THE AREA IN DEGREES. *
c *****
c
c      RR=3.14159265/180.0
c      NX2=NX/2+1
c      NX1=NX/2
c      NXX=NX+2
c      NY2=NY/2+1
c      NYY=NY+2
c      RNX=1.0/FLOAT(NX)
c      RNY=1.0/FLOAT(NY)
c
c      SINI=SIN(AINC*RR)

```

```

      COSI=COS (AINC*RR)
      SIND=SIN (DDEC*RR)
      COSD=COS (DDEC*RR)
C
      CON3=COSI*COSD
      CON2=COSI*SIND
C
      CONA=1.0/CMPLX (SINI,CON2)**2
      CONB=CONJG (CONA)
      X(1,1)=(0.0,0.0)
      DO 30 IX=2,NX1
        X (IX,1) =CONA
30    X (NXX-IX,1) =CONB
      X (NX2,1) =CONA
C
      CONA=1.0/CMPLX (SINI,CON3)**2
      CONB=CONJG (CONA)
      DO 50 IY=2,NY2
        IYY=NYY-IY
        FY=FLOAT (IY-1)*RNY
        FY2=FY*FY
        CFY=CON3*FY
        X (1,IYY) =CONB
        X (1,IY)  =CONA
        DO 40 IX=2,NX1
          IXX=NXX-IX
          FX=FLOAT (IX-1)*RNX
          CON4=SQRT (FX**2+FY2)
          X (IXX,IY) =1.0/CMPLX (SINI, (CFY-FX*CON2)/CON4)**2
          X (IX,IYY) =CONJG (X (IXX,IY))
          X (IX,IY)  =1.0/CMPLX (SINI, (FX*CON2+CFY)/CON4)**2
40    X (IXX,IYY) =CONJG (X (IX,IY))
          CON4=SQRT (0.25+FY2)
          X (NX2,IYY) =1.0/CMPLX (SINI, (0.5*CON2-CFY)/CON4)**2
50    X (NX2,IY)  =1.0/CMPLX (SINI, (0.5*CON2+CFY)/CON4)**2
C
      RETURN
      end

```



```

program avgdifres
character*80 filename
integer coln,rown,colk,rowk,var,row,col,set
dimension dndata(550,550),dkdata(550,550),avgdata(550,550),
> difdata(550,550),ddata(550,550)

c----- program description
c      avgdifres is a bashing of matrix manipulation. the program
c      will find the average of two input data sets, the difference
c      between them, and will resample (hence avg-dif-res aint science
c      great??) every other point, every third, fourth etc.. point.
c      if you want the average and difference of the input matrices
c      make sure you choose to resample every data point, ie choose
c      1 for 1x1.
c
c      write (*,*) '1 FOR ONE DATA SET'
c      write (*,*) '2 FOR TWO DATA SETS'
c      read (*,*) set
c
c      write (*,*) 'INPUT FILE OF DAWN GRIDDED ANOMALIES OR ONE DATA SET'
c      read (*,9990) filename
9990 format (a80)
c      open (10, file=filename,status='old',form='formatted')
c      if (set .eq. 1) go to 10
c      write (*,*) 'INPUT FILE OF DUSK GRIDDED ANOMALIES'
c      read (*,9990) filename
c      open (12, file=filename,status='old',form='formatted')
10      write (*,*) 'OUTPUT AVERAGED AND/OR RESAMPLED GRIDDED FILE'
c      read (*,9990) filename
c      open (20, file=filename,form='formatted')
c      if (set .eq. 1) go to 20
c      write (*,*) 'OUTPUT DIFFERENCE GRID OF (DUSK) - (DAWN)'
c      read (*,9990) filename
c      open (22, file=filename,form='formatted')
c
c      20      continue
c      write (*,*) 'RESAMPLE BY THIS NUMBER USE:'
c      write (*,*) '1 for keeping the average grid as is'
c      write (*,*) '2 for 2 degrees by 2 degrees'
c      write (*,*) '3 for 3 degrees by 3 degrees and so on'
c      read (*,*) var
c
c      read (10,*) coln
c      read (10,*) rown
c      read (10,*) xcolat
c      read (10,*) xlong
c      read (10,*) xgridspc
40      do 50 i=1,rown
c          read (10,*) (dndata(i,j),j=1,coln)
50      continue
c      if (set .eq. 1) go to 170
c      read (12,*) colk
c      read (12,*) rowk
c      read (12,*) ycolat
c      read (12,*) ylong
c      read (12,*) ygridspc
80      do 100 i=1,rowk
c          read (12,*) (dkdata(i,j),j=1,colk)
100     continue
c
c      if (coln.ne.colk .or. rown.ne.rowk) then
c          write (*,*) 'HEY NOW KIDS GRIDS ARE DIFFERENT SIZES'
c          write (*,*) coln,rown,colk,rowk
c          go to 999
c      endif
c
c----- find the average and difference matrices also
c      calculate the total and average RMS difference.
c
c      totrms=0.0
c      do 150 i=1,rown
c          do 150 j=1,coln
c              avgdata(i,j)=(dndata(i,j)+dkdata(i,j))/2.0
c              difdata(i,j)=dkdata(i,j)-dndata(i,j)
c              totrms=totrms+((sqrt((dndata(i,j)-dkdata(i,j))**2))/2.0)
150      continue
c      avgrms=totrms/(real(rown)*real(coln))
c
c      170      if (set .eq. 1) then
c          do 180 i=1,rown
c              do 180 j=1,coln
c                  avgdata(i,j)=dndata(i,j)
180          continue
c      endif
c
c----- this is the section that resamples
c
c      row=1
c      ii=1
200      jj=1
c      col=1
250      ddata(ii,jj)=avgdata(row,col)

```

```

        col=col+var
        if (col .gt. coln) go to 300
        jj=jj+1
        go to 250
300    row=row+var
        if (row .gt. rown) go to 400
        ii=ii+1
        go to 200
400    continue
c
        write (*,*) 'new rows=',ii,' new cols=',jj
        write (20,*) jj
        write (20,*) ii
        write (20,*) xcolat
        write (20,*) xlong
        write (20,*) real(var)
        do 450 k=1,ii
            write (20,9992) (ddata(k,l),l=1,jj)
450    continue
9992    format (6(f11.4,1x))
c
        if (set .eq. 1) go to 999
        write (22,*) coln
        write (22,*) rown
        write (22,*) ycolat
        write (22,*) ylong
        write (22,*) ygridspc
        do 500 m=1,rown
            write (22,9992) (difdata(m,n),n=1,coln)
500    continue
        write (*,*) 'total rms difference=',totrms
        write (*,*) 'average rms difference=',avgrms
c
999    continue
        close (10)
        close (12)
        close (20)
        close (22)
        stop
        end

```



C-41

C-41  
[illegible handwritten text]

```

      program sqrmap
      character*80 filename
      dimension xcore(100000),xxmag(100000),
>         core(361,361),xmag(361,361),xmultmag(400)
c
c----- program description
c      this program will find a least squares value of x that
c      can be multiplied by the difference matrix so that the
c      difference closer fits the dawn or dusk matrix. the
c      value of x is multiplied by the difference and subtracted
c      from the dawn or dusk grid to make an output grid.
c      NOTE: i realize i'm making the 2-D arrays
c            into 1-D arrays
c
      write (*,*) 'input difference matrix'
      read (*,9990) filename
      9990 format (a80)
      open (10, file=filename,form='formatted',status='old')
      write (*,*) 'input dawn or dusk matrix of total field values'
      read (*,9990) filename
      open (11, file=filename,form='formatted',status='old')
      write (*,*) 'output (total field) - (x)(difference)'
      read (*,9990) filename
      open (20, file=filename,form='formatted')
c
      cmean=0.0
      fmean=0.0
      read (10,*) icol
      read (10,*) irow
      read (10,*) south
      read (10,*) west
      read (10,*) gridspec
      do i=1,irow
        read (10,*) (core(i,j),j=1,icol)
        do j=1,icol
          cmean=cmean+core(i,j)
        enddo
      enddo
c
      read (11,*) imcol
      read (11,*) imrow
      read (11,*) south
      read (11,*) west
      read (11,*) gridspec
      do i=1,imrow
        read (11,*) (xmag(i,j),j=1,imcol)
        do j=1,imcol
          fmean=fmean+xmag(i,j)
        enddo
      enddo
      if (irow.ne.imrow .or. icol.ne.imcol ) then
        write (*,*) 'rows cor mag ',irow,imrow
        write (*,*) 'cols cor mag ',icol,imcol
        stop 10
      endif
      cmean=cmean/real(irow*icol)
      fmean=fmean/real(irow*imcol)
c
c----- remove the mean values
      do 500 i=1,irow
        do 500 j=1,icol
          xmag(i,j)=xmag(i,j)-fmean
          core(i,j)=core(i,j)-cmean
        500
      enddo
c----- turn the 2-D arrays into 1-D (cheater)
      do i=1,irow
        do j=1,icol
          ii=((i-1)*icol)+j
          xxmag(ii)=xmag(i,j)
          xcore(ii)=core(i,j)
        enddo
      enddo
c----- find a scalar value of c transpose c
      ctc=0.0
      do 600 i=1,ii
        600 ctc=(xcore(i)*xcore(i))+ctc
c
c----- find (c transpose c) inverse
      ctcinv=1.0/ctc
c
      ctf=0.0
      do 700 i=1,ii
        700 ctf=(xcore(i)*xxmag(i))+ctf
c----- find x
      x=ctcinv*ctf
      write (*,*) 'the value of x = ', x
c
      write (20,*) imcol
      write (20,*) imrow
      write (20,*) south

```

```

      write (20,*) west
      write (20,*) gridspe
      do i=1,irow
        do j=1,icol
          xmultmag(j)=xmag(i,j)-(x)*(core(i,j))
        enddo
        write (20,9991) (xmultmag(j),j=1,icol)
      enddo
9991 format (6(f11.4,1x))
c
999 continue
stop
end

```



```

program inversion
DIMENSION DW(3982),DP(3982),DFS(361,44)
COMMON XORD,YORD,DXD,DYD,NXD,NYD,RO,RD,E,G,COST,SINT,YC,THETA,PHI,
> P(3982),TMAG(3982),DF(361,44),S(7930153)
EQUIVALENCE (DW(1),P(1)), (DP(1),TMAG(1))
REAL I,INC(361),D,DEC(361),FLD(361),I1,D1,F1,myear,mi,md,
> m11,md1,mf1,mxoro,myoro,mdxo,mdyo,melvo
real fldd,fldo,incd,inco,decd,deco
dimension fldd(44,181),fldo(44,361),incd(44,181),inco(44,361),
> decd(44,181),deco(44,361)
common /gmf/ fldd,fldo,incd,inco,decd,deco
character*80 filename
integer choice
C
C*****
C
C PROGRAM NVERTSM CALCULATES A SET OF CGS-SUSCEPTIBILITIES FOR AN
C NXD-BY-NYD SPHERICAL ARRAY OF POINT DIPOLES SUCH THAT THE RESUL-
C TANT EQUIVALENT SOURCE FIELD IS A LEAST-SQUARES BEST FIT TO MAG-
C NETIC DATA OBSERVED OVER AN NXO-BY-NYO SPHERICAL GRID. OUTPUT
C CONSISTS OF LISTINGS AND/OR PUNCHED DECKS OF EQUIVALENT SOURCE
C SUSCEPTIBILITIES AND/OR ANOMALY VALUES (SEE DATA CARD 1 BELOW).
C
C DIMENSIONING REQUIREMENTS.....
C DIMENSION DW(NXD*NYD),DP(NXD*NYD),P(NXD*NYD),TMAG(NXD*NYD),
C DF(NXO,NYO),S(NIJ) WHERE NIJ=(NXD*NYD)*(NXD*NYD+1)/2, FLD1(NXD),
C INC1(NXD),D1(NXD),FLD(NXO),I(NXO),D(NXO)
C
C this program has been slightly modified from a view point of
C lines of code. these changes are all lower case. however from
C the view point of run time it should now take less than 1/4 !!!
C of the time that it took in the past. this is because no reads
C from files 10 or 11 are necessary as all arrays are stored in
C memory.
C
C modifications made 15 may 90
C
C further changes on 22 Sep 90
C these changes are mostly removal of unnecessary write
C statements and general cleanup of the program.
C
C more changes on 2 Jan 91
C this update included the addition of a few lines of code
C that allows for input of a file of susceptibilities and
C output of a magnetic field map.
C
C***** DATA INPUT SEQUENCE *****
C
C write (*,*) '0 IF YOU HAVE A FILE FOR THE VARIABLES'
C write (*,*) '1 IF YOU WANT TO TYPE VARIABLES INTERACTIVELY'
C read (*,*) choice
C if (choice.eq. 0) go to 10
C write (*,9991)
9991 format('NFLD=0 DO NOT CALCULATE EQUIVALENT SOURCE M-FIELD'/
> ' -1 CALCULATE EQUIVALENT SOURCE M-FIELD'/
> ' -2 GIVEN THE CGS-SUSCEPTIBILITIES THE PROGRAM'/
> ' WILL CALCULATE THE EQUIV SRC M-FLD'/
> ' NIO=0 DO NOT WRITE A FILE SUSCEPTIBILITIES'/
> ' -1 WRITE OUT A SEPARATE FILE OF SUSCEPTIBILITIES'/
> ' NFLD(1) NIO(0)')
C read (*,*) nfld,nio
C
C if (nfld.eq. 1) then
C write (*,*) ' '
C write (*,*) 'the following refers to calculation of the',
> ' susceptibilities'
C write (*,*) ' '
C endif
C write (*,9992)
9992 format('NXO= NUMBER OF LONGITUDINAL COLS OF OBSERVATION GRID'/
> ' NYO= NUMBER OF LATITUDINAL ROWS OF OBSERVATION GRID'/
> ' XORO= WESTERN-MOST LONGITUDINAL COORDINATE OF OBSERVATION'/
> ' GRID IN -180.0 to 180.0 DEGREES'/
> ' YORO= SOUTHERN-MOST LATITUDINAL COORDINATE OF OBSERVATION'/
> ' GRID IN -90.0 to 90.0 DEGREES'/
> ' DXO= LONGITUDINAL STATION SPACING OF OBSERVATION GRID IN DEGS'/
> ' DYO= LATITUDINAL STATION SPACING OF OBSERVATION GRID IN DEGS'/
> ' ELVO= ELEVATION OF OBSERVATION GRID IN KILOMETERS (350.0)')
> ' NXO NYO XORO YORO DXO DYO ELVO '
C read (*,*) nxo,nyo,xoro,yoro,dxo,dyo,elvo
C
C write (*,9993)
9993 format('NXD= NUMBER OF LONGITUDINAL COLS OF SOURCE GRID'/
> ' NYD= NUMBER OF LATITUDINAL ROWS OF SOURCE GRID'/
> ' XORD= WESTERN-MOST LONGITUDINAL COORDINATE OF SOURCE'/
> ' GRID IN -180.0 to 180.0 DEGREES'/
> ' YORD= SOUTHERN-MOST LATITUDINAL COORDINATE OF SOURCE'/
> ' GRID IN -90.0 to 90.0 DEGREES'/
> ' DXD= LONGITUDINAL STATION SPACING OF SOURCE GRID IN DEGREES'/
> ' DYD= LATITUDINAL STATION SPACING OF SOURCE GRID IN DEGREES'/

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>'ELVD= ELEVATION OF SOURCE GRID IN KILOMETERS (-50.0)('//
>'NXD NYD XORD YORD DXD DYD ELVD '
read (*,*) nxd,nyd,xord,yord,dxd,dyd,elvd
c
  write (*,9994)
9994 format ('YEAR= EPOCH IN YEARS AND DECIMAL FRACTION YEARS'/
>' E.G., 1965.75 = 1 OCT 65 FOR WHICH THE'/
>' GEOMAGNETIC REFERENCE FIELD IS TO'/
>' BE COMPUTED AT SOURCE AND/OR OBSERVATION POINTS'/
>' = 0 USER SUPPLIES CHARACTERISTICS OF SOURCE POLARIZATION'/
>' FIELD (F1,I1,D1) AND GEOMAGNETIC FIELD (I,D) OVER'/
>' OBSERVATION GRID'/
>'F1= SCALAR MAGNETIC INTENSITY IN GAMMAS OF SOURCE POLARIZATION'/
>' FIELD.'/
>'I1= INCLINATION IN DEGREES OF SOURCE POLARIZING FIELD'/
>'D1= DECLINATION IN DEGREES OF SOURCE POLARIZING FIELD'//
>'NOTE---IF (F1+I1+D1).EQ.0.0, THEN THE SOURCE POLARIZING'/
>' FIELD IS COMPUTED BY SUBROUTINE FIELDG FOR EPOCH'/
>' SPECIFIED BY THE YEAR-INPUT VARIABLE'//
>' YEAR (1980.0) F1 (0.0) I1 (0.0) D1 (0.0)')
read (*,*) year,f1,i1,d1
c
  write (*,9995)
9995 format ('I= INCLINATION IN DEGREES OF THE GEOMAGNETIC FIELD'/
>' OVER THE OBSERVATION POINTS'/
>'D= DECLINATION IN DEGREES OF THE GEOMAGNETIC FIELD OVER THE'/
>' OBSERVATION POINTS'//
>'NOTE---IF (I+D).EQ.0.0, THEN THE GEOMAGNETIC FIELD OVER THE'/
>' OBSERVATION POINT IS COMPUTED BY SUBROUTINE FIELDG'/
>' FOR THE EPOCH SPECIFIED BY THE YEAR-INPUT VARIABLE'//
>' I (0.0) D (0.0)')
read (*,*) i,d
write (*,*) 'ERROR FACTOR FOR VARIANCE (fak) (0.10E-7) '
read (*,*) fak
c
  if (nfld .eq. 0) go to 15
  write (*,*) ' '
  write (*,*) 'the following refers to calculation of the'
  write (*,*) 'equivalent source magnetic field'
  write (*,*) ' '
c
  write (*,9998)
9998 format ('mNXO= NUMBER OF LONGITUDINAL COLS OF OBSERVATION GRID'/
>'mNYO= NUMBER OF LATITUDINAL ROWS OF OBSERVATION GRID'/
>'mXORO= WESTERN-MOST LONGITUDINAL COORDINATE OF OBSERVATION'/
>' GRID IN -180.0 to 180.0 DEGREES'/
>'mYORO= SOUTHERN-MOST LATITUDINAL COORDINATE OF OBSERVATION'/
>' GRID IN -90.0 to 90.0 DEGREES'/
>'mDXO= LONGITUDINAL STATION SPACING OF OBSERVATION GRID IN DEGS'/
>'mDYO= LATITUDINAL STATION SPACING OF OBSERVATION GRID IN DEGS'/
>'mELVO= ELEVATION OF OBSERVATION GRID IN KILOMETERS (350.0)('//
>'mNXO mNYO mXORO mYORO mDXO mDYO mELVO '
read (*,*) mnxo,mnyo,mxoro,myoro,mdxo,mdyo,melvo
c
  write (*,9996)
9996 format ('mYEAR= EPOCH IN YEARS AND DECIMAL FRACTION YEARS'/
>' E.G., 1965.75 = 1 OCT 65 FOR WHICH THE'/
>' GEOMAGNETIC REFERENCE FIELD IS TO'/
>' BE COMPUTED AT SOURCE AND/OR OBSERVATION POINTS'/
>' = 0 USER SUPPLIES CHARACTERISTICS OF SOURCE POLARIZATION'/
>' FIELD (F1,I1,D1) AND GEOMAGNETIC FIELD (I,D) OVER'/
>' OBSERVATION GRID'/
>'mF1= SCALAR MAGNETIC INTENSITY IN GAMMAS OF SOURCE POLARIZATION'/
>' FIELD.'/
>'mI1= INCLINATION IN DEGREES OF SOURCE POLARIZING FIELD'/
>'mD1= DECLINATION IN DEGREES OF SOURCE POLARIZING FIELD'//
>'NOTE---IF (mF1+mI1+mD1).EQ.0.0, THEN THE SOURCE POLARIZING'/
>' FIELD IS COMPUTED BY SUBROUTINE FIELDG FOR EPOCH'/
>' SPECIFIED BY THE YEAR-INPUT VARIABLE'//
>'mYEAR (0.0) mF1 (60000.0) mI1 (90.0) mD1 (0.0)')
read (*,*) myear,mf1,mil,mdl
c
  write (*,9997)
9997 format ('mI= INCLINATION IN DEGREES OF THE GEOMAGNETIC FIELD'/
>' OVER THE OBSERVATION POINTS'/
>'mD= DECLINATION IN DEGREES OF THE GEOMAGNETIC FIELD OVER THE'/
>' OBSERVATION POINTS'//
>'NOTE---IF (mI+mD).EQ.0.0, THEN THE GEOMAGNETIC FIELD OVER THE'/
>' OBSERVATION POINT IS COMPUTED BY SUBROUTINE FIELDG'/
>' FOR THE EPOCH SPECIFIED BY THE YEAR-INPUT VARIABLE'//
>'mI (90.0) mD (0.0)')
read (*,*) mI,md
write (*,*) '0 DO NOT SUBTRACT MEAN OF FINAL R-T-P MAP'
write (*,*) '1 SUBTRACT THE MEAN'
read (*,*) isub
go to 15
c
10 write (*,*) 'INPUT FILE OF NUMBERS FOR VARIABLES'
read (*,9990) filename
open (17, file=filename,status='old',form='formatted')

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      READ (17,*) NFLD,NIO
      READ (17,*) NXO,NYO,XORO,YORO,DXO,DYO,ELVO
      READ (17,*) NXD,NYD,XORD,YORD,DXD,DYD,ELVD
      READ (17,*) YEAR,F1,I1,D1,I,D
      read (17,*) fak
      read (17,*) mnxo,mnyo,mxoro,myoro,mdxo,mdyo,melvo
      read (17,*) myear,mf1,m1l,md1,m1,md
      read (17,*) isub
c
15  write (*,*) 'INPUT FILE OF GRIDDED ANOMALY DATA OR SUSC DATA'
      write (*,*) 'DATA SHOULD BE WEST TO EAST AND SOUTH TO NORTH'
c----- array df(ix,jy) reads the anomaly data
c          in gammas or nanoteslas with the input
c          starting with the southernmost latitude
c          at the westernmost longitude.
      read (*,9990) filename
9990 format (a80)
      open (13, file=filename,status='old',form='formatted')
      write (*,*) 'INPUT FILE OF SPHERICAL HARMONIC COEFFICIENTS'
      write (*,*) 'SUCH AS GSFC1283'
      read (*,9990) filename
      open (3, file=filename,status='old',form='formatted')
c      open (3, file='../data/mgst1283',status='old',
c      > form='formatted')
      if (nfl .eq. 1 .or. nfl .eq. 2) then
        write (*,*) 'OUTPUT FILE OF EQUIVALENT SOURCE M-FIELD'
        read (*,9990) filename
        open (30, file=filename,form='formatted')
      endif
      if (nio .eq. 1) then
        write (*,*) 'OUTPUT FILE OF SUSCEPTIBILITIES'
        read (*,9990) filename
        open (33, file=filename,form='formatted')
      endif
      write (*,*) 'OUTPUT INFORMATION FILE OF A BUNCH OF STUFF!!'
      read (*,9990) filename
      open (6, file=filename,form='formatted')
c
      if (nfl .eq. 2) go to 155
c
      WRITE(6,520) NXO,NYO,XORO,YORO,DXO,DYO,ELVO
      WRITE(6,540) NXD,NYD,XORD,YORD,DXD,DYD,ELVD
c
      IF (YEAR.LT.1.E-9) WRITE(6,420) F1,I1,D1,I,D
      IF (F1+I1+D1.LT.1.E-9.AND.I+D.GT.0.0) WRITE(6,430) YEAR,I,D
      IF (I+D.LT.1.E-9.AND.F1+I1+D1.GT.0.0) WRITE(6,440) YEAR,F1,I1,D1
      IF (I+D.LT.1.E-9.AND.F1+I1+D1.LT.1.E-9) WRITE(6,450) YEAR
c
c      CALCULATE THE GEOMAGNETIC FIELD OVER THE SOURCE AND/OR OBSERVATION
c      GRIDS, RESPECTIVELY
c
      IF (YEAR.LT.1.E-9) GO TO 120
      LQ=1
c
      CALL FIELDG (0.,0.,0.,0.,55,LQ,Q1,Q2,Q3,Q4)
c
      IF (F1+I1+D1.GT.0.0) GO TO 110
c
      CALL GEOMAG (YEAR,ELVD,YORD,XORD,DYD,DXD,NYD,NXD,11)
c
110 IF (I+D.GT.0.0) GO TO 120
c
      CALL GEOMAG (YEAR,ELVO,YORO,XORO,DYO,DXO,NYO,NXO,10)
c
120 CONTINUE
c
      read (13,*) iew
      read (13,*) ins
      read (13,*) scolat
      read (13,*) west
      read (13,*) gridspc
      DO 130 JY=1,NYO
        READ (13,*) (DF(IX,JY),IX=1,NXO)
130 continue
c
c      COMPUTE MAXIMUM, MINIMUM AND AVERAGE AMPLITUDE VALUES FOR M-FIELD
c      INPUT DATA
c
      DSUM=0.0
      DMIN=DF(1,1)
      DMAX=DMIN
      DO 140 JY=1,NYO
        DO 140 IX=1,NXO
          DSUM=DSUM+DF(IX,JY)
          IF (DMAX.LT.DF(IX,JY)) DMAX=DF(IX,JY)
          IF (DMIN.GT.DF(IX,JY)) DMIN=DF(IX,JY)
140 CONTINUE
      DSUM=DSUM/FLOAT(NXO*NYO)
      WRITE(6,640) DMAX,DMIN,DSUM
c

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C      save values for the reduction-to-pole
C
155  istrnxd=nxd
    istrnyd=nyd
    strxord=xord
    stryord=yord
    strdxord=dxord
    strdyord=dyord
    strrelvd=elvd
    if (nflld .eq. 2) go to 840
C
C      CONVERT LAT AND LONG TO RADIANS AND ELEVATIONS TO EARTH RADII
C
    PI=3.1415926536
    FACT=PI/180.0
C
    XORO=XORO*FACT
    XORD=XORD*FACT
    YORO=(90.0-YORO)*FACT
    YORD=(90.0-YORD)*FACT
    DXO=DXO*FACT
    DXD=DXD*FACT
    DYO=-DYO*FACT
    DYD=-DYD*FACT
C
    I=I*FACT
    D=-D*FACT
    I1=I1*FACT
    D1=-D1*FACT
C
    REARTH=6371.0
    RO=ELVO+REARTH
    RD=ELVD+REARTH
    E=RD**2+RO**2
    G=2.0*RD*RO
    NP=(NXD*NYD)
    DO 150 JY=1,NP
      P(JY)=0.0
      DW(JY)=0.0
150  CONTINUE
C
    NIJ=NP*(NP+1)/2
    DO 160 JY=1,NIJ
160  S(JY)=0.0
C
C      COMPUTE WEIGHTING COEFFICIENTS, DW(L), L=1,NP
C
C      COMPUTE UPPER HALF OF SYMMETRIC A(TRANSPPOSE)A MATRIX OF 1-ST ORDER
C      PARTIALS AND STORE AS 1-DIMENSIONAL ARRAY S(LLL), LLL=1,NIJ---I.E.
C      A(TRANSPPOSE)A(I,J)=S(IJ), WHERE IJ=I*(I-1)/2+J
C
    IF (YEAR.LT.1.E-9) GO TO 180
    IF (F1+I1+D1.GT.0.0.AND.I+D.LT.1.E-9) GO TO 200
    IF (F1+I1+D1.LT.1.E-9.AND.I+D.GT.0.0) GO TO 220
C
C      COMPUTE A(TRANSPPOSE)A MATRIX FOR CASE WHERE (I,D) AND (F1,I1,D1)
C      ARE DERIVED FROM FIELDG
C
    DO 170 JY=1,NYO
      THETA=YORO+(FLOAT(JY)-1.0)*DYO
      COST=COS(THETA)
      SINT=SIN(THETA)
C
      DO 175 l=1,nxo
        fld(l)=fldo(jy,l)
        inc(l)=inco(jy,l)
        dec(l)=deco(jy,l)
175      continue
      DO 170 IX=1,NXO
        PHI=XORO+(FLOAT(IX)-1.0)*DXO
        AI=INC(IX)
        AD=DEC(IX)
C
        CALL MAGS1 (AI,AD)
C
        DY=DF(IX,JY)-YC
        LLL=0
        DO 170 L=1,NP
          DW(L)=DW(L)+TMAG(L)*DY
        DO 170 K=1,L
          LLL=LLL+1
          S(LLI)=S(LLI)+TMAG(L)*TMAG(K)
170      CONTINUE
        GO TO 240
C
C      COMPUTE A(TRANSPPOSE)A MATRIX FOR CASE WHERE USER SUPPLIES (I,D)
C      AND (F1,I1,D1)
C
180  DO 190 JY=1,NYO
      THETA=YORO+(FLOAT(JY)-1.0)*DYO

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      COST=COS(THETA)
      SINT=SIN(THETA)
DO 190 IX=1,NXO
  PHI=XORO+(FLOAT(IX)-1.0)*DXO
C
  CALL MAGS2 (I,D,F1,I1,D1)
C
  DY=DF(IX,JY)-YC
C
  LLL=0
DO 190 L=1,NP
  DW(L)=DW(L)+TMAG(L)*DY
DO 190 K=1,L
  LLL=LLL+1
  S(LLL)=S(LLL)+TMAG(L)*TMAG(K)
190 CONTINUE
  GO TO 240
C
C   COMPUTE A (TRANSPOSE)A MATRIX FOR CASE WHERE (I,D) ARE DERIVED
C   FROM FIELDG AND USER SUPPLIES (F1,I1,D1)
C
200 DO 210 JY=1,NYO
  THETA=YORO+(FLOAT(JY)-1.0)*DYO
  COST=COS(THETA)
  SINT=SIN(THETA)
C
  do 185 l=1,nxo
    fld(l)=fldo(jy,l)
    inc(l)=inco(jy,l)
    dec(l)=deco(jy,l)
185  continue
C
  DO 210 IX=1,NXO
    PHI=XORO+(FLOAT(IX)-1.0)*DXO
    AI=INC(IX)
    AD=DEC(IX)
C
    CALL MAGS2 (AI,AD,F1,I1,D1)
C
    DY=DF(IX,JY)-YC
C
    LLL=0
DO 210 L=1,NP
  DW(L)=DW(L)+TMAG(L)*DY
DO 210 K=1,L
  LLL=LLL+1
  S(LLL)=S(LLL)+TMAG(L)*TMAG(K)
210 CONTINUE
  GO TO 240
C
C   COMPUTE A (TRANSPOSE)A MATRIX FOR CASE WHERE USER SUPPLIES (I,D)
C   AND (F1,I1,D1) ARE DERIVED FROM FIELDG
C
220 DO 230 JY=1,NYO
  THETA=YORO+(FLOAT(JY)-1.0)*DYO
  COST=COS(THETA)
  SINT=SIN(THETA)
DO 230 IX=1,NXO
  PHI=XORO+(FLOAT(IX)-1.0)*DXO
C
  CALL MAGS1 (I,D)
C
  DY=DF(IX,JY)-YC
  LLL=0
DO 230 L=1,NP
  DW(L)=DW(L)+TMAG(L)*DY
DO 230 K=1,L
  LLL=LLL+1
  S(LLL)=S(LLL)+TMAG(L)*TMAG(K)
230 CONTINUE
240 CONTINUE
C----- if a transpose a without error
c      variance is wanted then use
c      write (20).
c      WRITE(20) (S(J),J=1,LLL)
C----- if a transpose observations without
c      error variance is wanted then use
c      write (25).
c      WRITE(25) (DW(L),L=1,NP)
C----- the following loop adds fak to the diagonal
c      of aTa
      II=0
DO 888 J=1,NP
  II=II+J
  S(II)=S(II)+FAK
888 CONTINUE
C
C   COMPUTE INVERSE OF S-ARRAY
C

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      CALL SPPCO (S,NP,RCOND,DP,INFO)
C
      WRITE(6,480) RCOND
      IF (INFO.NE.0) WRITE(6,490) INFO
      DO 250 IX=1,NP
250  DP (IX)=DW (IX)
C
      CALL SPPSL (S,NP,DP)
C
C      WRITE OUT COORDINATE CHARACTERISTICS OF M-DIPOLES
C
      WRITE(6,590)
      L=0
      DO 260 JY=1,NYD
        YLAT=90.0-(YORD+FLOAT(JY-1)*DYD)/FACT
        DO 260 IX=1,NXD
          L=L+1
          XLON=(XORD+FLOAT(IX-1)*DXD)/FACT
          WRITE(6,600) DP (L),XLON,YLAT,ELVD
260  CONTINUE
      DO 270 JY=1,NP
270  P (JY)=DP (JY)
C
C      IF NIO = 1 WRITE SUSCEPTIBILITIES ONTO USER DEFINED UNIT 33
C
      if (nio .eq. 1) then
        write (33,*) iew
        write (33,*) ins
        write (33,*) scolat
        write (33,*) west
        write (33,*) gridspe
        IJK=1
        DO 375 JY=1,NYD
          IJK1=IJK+NXD-1
          WRITE(33,'(4(E18.8,1x))') (DP (L),L=IJK,IJK1)
          IJK=IJK1+1
375  CONTINUE
        endif
C
      IF (NFILE.EQ.0) GO TO 410
      WRITE (6,620)
C
C      COMPUTE EQUIVALENT SOURCE M-FIELD
C
840  continue
      WRITE(6,630)
      nxd=istrnxd
      nyd=istrnyd
      xord=strxord
      yord=stryord
      dxd=strdxd
      dyd=strdyd
      elvd=strelvd
      if (nfile .eq. 2) then
        read (13,*) iew
        read (13,*) ins
        read (13,*) scolat
        read (13,*) west
        read (13,*) gridspe
        do jy=1,nyd
          read (13,*) (df (ix,jy),ix=1,nxd)
        enddo
        DO JY=1,NYD
          do ix=1,nxd
            L=((jy-1)*nxd)+ix
            P (L)=df (ix,jy)
          enddo
        enddo
      endif
C
      IF (myear.LT.1.E-9) GO TO 880
      call fieldg (0.,0.,0.,0.,55,1,q1,q2,q3,q4)
      if (mfl+mil+mdl .gt. 0.0) go to 870
      call geomag (myear,elvd,yord,xord,dyd,dxd,nyd,nxd,11)
870  if (mi+md .gt. 0.0) go to 880
      call geomag (myear,melvo,myoro,mxoro,mdyo,mdxo,mnyo,mnxo,10)
C
880  continue
C
      PI=3.1415926536
      FACT=PI/180.0
C
      mXORO=mXORO*FACT
      XORD=XORD*FACT
      mYORO=(90.0-mYORO)*FACT
      YORD=(90.0-YORD)*FACT
      mDXO=mDXO*FACT
      DXD=DXD*FACT
      mDYO=-mDYO*FACT
      DYD=-DYD*FACT

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C      mI=mI*FACT
      mD=-mD*FACT
      mI1=mI1*FACT
      mD1=-mD1*FACT
C
      REARTH=6371.0
      RO=mELVO+REARTH
      RD=ELVD+REARTH
      E=RD**2+RO**2
      G=2.0*RD*RO
C
      IF (mYEAR.LT.1.E-9) GO TO 300
      IF (mF1+mI1+mD1.GT.0.0 .AND. mI+mD.LT.1.E-9) GO TO 330
      IF (mF1+mI1+mD1.LT.1.E-9 .AND. mI+mD.GT.0.0) GO TO 360
C
C      COMPUTE M-FIELD FOR CASE WHERE (mI,mD) AND (mF1,mI1,mD1)
C      ARE DERIVED FROM FIELDG
C
      DO 290 JY=1,mNYO
        THETA=mYORO+(FLOAT(JY)-1.0)*mDYO
        COST=COS(THETA)
        SINT=SIN(THETA)
C
        do 195 l=1,mNXO
          fld(l)=fldo(jy,l)
          inc(l)=inco(jy,l)
          dec(l)=deco(jy,l)
195      continue
C
        DO 280 IX=1,mNXO
          PHI=mXORO+(FLOAT(IX)-1.0)*mDXO
          aI=INC(IX)
          aD=DEC(IX)
C
          CALL MAGS1 (aI,aD)
C
        280   DFS(IX,JY)=YC
        290   WRITE(6,580) (DFS(IX,JY),IX=1,mNXO)
              GO TO 390
C
C      COMPUTE M-FIELD FOR CASE WHERE USER SUPPLIES (mI,mD)
C      AND (mF1,mI1,mD1)
C
        300 DO 320 JY=1,mNYO
          THETA=mYORO+(FLOAT(JY)-1.0)*mDYO
          COST=COS(THETA)
          SINT=SIN(THETA)
          DO 310 IX=1,mNXO
            PHI=mXORO+(FLOAT(IX)-1.0)*mDXO
C
            CALL MAGS2 (mI,mD,mF1,mI1,mD1)
C
          310   DFS(IX,JY)=YC
          320   WRITE(6,580) (DFS(IX,JY),IX=1,mNXO)
              GO TO 390
C
C      COMPUTE M-FIELD FOR CASE WHERE (mI,mD) ARE DERIVED FROM
C      FIELDG AND USER SUPPLIES (mF1,mI1,mD1)
C
        330 DO 350 JY=1,mNYO
          THETA=mYORO+(FLOAT(JY)-1.0)*mDYO
          COST=COS(THETA)
          SINT=SIN(THETA)
C
          do 205 l=1,mNXO
            fld(l)=fldo(jy,l)
            inc(l)=inco(jy,l)
            dec(l)=deco(jy,l)
205      continue
C
          DO 340 IX=1,mNXO
            PHI=mXORO+(FLOAT(IX)-1.0)*mDXO
            aI=INC(IX)
            aD=DEC(IX)
C
            CALL MAGS2 (aI,aD,mF1,mI1,mD1)
C
          340   DFS(IX,JY)=YC
          350   WRITE(6,580) (DFS(IX,JY),IX=1,mNXO)
              GO TO 390
C
C      COMPUTE M-FIELD FOR CASE WHERE USER SUPPLIES (mI,mD) AND
C      (mF1,mI1,mD1) ARE DERIVED FROM FIELDG
C
        360 DO 380 JY=1,mNYO
          THETA=mYORO+(FLOAT(JY)-1.0)*mDYO
          COST=COS(THETA)
          SINT=SIN(THETA)
          DO 370 IX=1,mNXO
            PHI=mXORO+(FLOAT(IX)-1.0)*mDXO

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```

C          CALL MAGS1 (mI,mD)
C
C 370      DFS(IX,JY)=YC
C 380 WRITE(6,580) (DFS(IX,JY),IX=1,mNXO)
C 390 CONTINUE
C
C      COMPUTE MAXIMUM, MINIMUM AND AVERAGE AMPLITUDE VALUES FOR EQUIVA-
C      LENT SOURCE M-FIELD
C
C      DSUM=0.0
C      DMIN=DFS(1,1)
C      DMAX=DMIN
C      DO 400 JY=1,mNYO
C      DO 400 IX=1,mNXO
C          DSUM=DSUM+DFS(IX,JY)
C          IF (DMAX.LT.DFS(IX,JY)) DMAX=DFS(IX,JY)
C          IF (DMIN.GT.DFS(IX,JY)) DMIN=DFS(IX,JY)
C 400 CONTINUE
C      DSUM=DSUM/FLOAT(mNXO*mNYO)
C      WRITE(6,640) DMAX,DMIN,DSUM
C
C      if (isub .eq. 0) dsum=0.0
C      dmax=dfs(1,1)
C      dmin=dmax
C      write (30,*) mnxo
C      write (30,*) mnyo
C      write (30,*) myoro/fact
C      write (30,*) mxoro/fact
C      write (30,*) mdxo/fact
C      DO 385 JY=1,mNYO
C          WRITE(30,580) ((DFS(IX,JY)-dsum),IX=1,mNXO)
C          do 385 ix=1,mnxo
C              dmax=max(dmax,(dfs(ix,jy)-dsum))
C              dmin=min(dmin,(dfs(ix,jy)-dsum))
C 385 CONTINUE
C      if (isub .eq. 1) write (6,*) 'new max=',dmax,' new min=',dmin
C
C 410 CONTINUE
C      SSUM=0.0
C      DO 900 II=1,mNXO
C      DO 900 J=1,mNYO
C          SSUM=SSUM+(DF(II,J)-DFS(II,J))**2
C 900 CONTINUE
C      WRITE(6,790) SSUM
C 790 FORMAT(' SUM OF SQUARES = ',E15.10)
C 901 CONTINUE
C      STOP
C
C 420 FORMAT (/,1X,3HF1=,F10.3,5X,3HI1=,F6.2,5X,3HD1=,F6.2,5X,2HI=,F6.2,
C 15X,2HD=,F6.2,/)
C 430 FORMAT (/,1X,5HYEAR=,F10.5,5X,2HI=,F6.2,5X,2HD=,F6.2,/)
C 440 FORMAT (/,1X,5HYEAR=,F10.5,5X,3HF1=,F10.3,5X,3HI1=,F6.2,5X,3HD1=,F
C 16.2,/)
C 450 FORMAT (/,1X,5HYEAR=,F10.5,/)
C 480 FORMAT (//,2X, 7HRCOND =,E20.8)
C 490 FORMAT (//,2X,26HATA LEADING MINOR OF ORDER,I5,1X,24HIS NOT POSITI
C 1VE DEFINITE)
C 520 FORMAT (2X,4HNKO=,I5,5X,4HNYO=,I5,5X,5HXORO=,F10.5,5X,5HYORO=,F10.
C 15,5X,4HDKO=,F10.5,5X,4HDYO=,F10.5,5X,5HELVO=,F10.5,/)
C 540 FORMAT (2X,4HNKD=,I5,5X,4HNYD=,I5,5X,5HXORD=,F10.5,5X,5HYORD=,F10.
C 15,5X,4HDKD=,F10.5,5X,4HDYD=,F10.5,5X,5HELVD=,F10.5,/)
C 580 FORMAT (8(1X,F9.3))
C 590 FORMAT (//, 'CGS-SUSCEPTIBILITIES',5X, 'E-LONGITUDE',5X, 'N-',
C >'LATITUDE',5X, 'KM-ELEVATION',/)
C 600 FORMAT (1X,E20.5,5X,F10.4,5X,F10.4,5X,F10.4)
C 620 FORMAT (///)
C 630 FORMAT (//,2X,25HEQUIVALENT SOURCE M-FIELD,/)
C 640 FORMAT (//,2X,5HDMAX=,F10.3,10X,5HDMIN=,F10.3,10X,5HDAVG=,F10.3)
C
C      END
C      SUBROUTINE MAGS1 (I,D)
C
C *****
C      SUBROUTINE MAGS1 CALCULATES THE TOTAL MAGNETIC FIELD AT A SPHERICAL
C      OBSERVATION POINT (R,THETA,PHI) DUE TO A SPHERICAL ARRAY OF POINT
C      DIPOLES WITH CGS-SUSCEPTIBILITIES P(L) AT SOURCE GRID COORDINATES
C      (R1,THETA1,PHI1). POLARIZING FIELD CHARACTERISTICS (F1,I1,D1)
C      ARE READ FROM TAPE11.
C *****
C
C      COMMON XORD,YORD,DXD,DYD,NXD,NYD,RO,RD,E,G,COST,SINT,YC,THETA,PHI,
C >P(3982),TMAG(3982),DF(361,44),S(7930153)
C      real fldd,fldo,incd,inco,decd,deco
C      dimension fldd(44,181),fldo(44,361),incd(44,181),inco(44,361),
C > decd(44,181),deco(44,361)
C      common /gmf/fldd,fldo,incd,inco,decd,deco
C      REAL I,I1,JR,JTHETA,JPHI,INC1(181),FLD1(181),DEC1(181)
C      YC=0.0
C      L=0

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```

DO 110 JY=1,NYD
  THETA1=YORD+FLOAT(JY-1)*DYD
  COST1=COS(THETA1)
  SINT1=SIN(THETA1)
  CT1T=COST1*COST
  ST1T=SINT1*SINT
  SC1T=SINT1*COST
  CS1T=COST1*SINT
C
  DO 730 K=1,NXD
    FLD1(K)=FLDD(JY,K)
    INCL(K)=INCD(JY,K)
    DEC1(K)=DECD(JY,K)
730    CONTINUE
C
DO 110 IX=1,NXD
  L=L+1
C
C   COMPUTE POINT DIPOLE POLARIZATION VECTOR IN SPHERICAL ORTHONORMAL
C   UNIT VECTORS (ER,ETHETA,EPhi) WITH SUCEP(L)=1.0
C
  F1=FLD1(IX)
  I1=INCL(IX)
  D1=DEC1(IX)
C
  JR=F1*SIN(I1)
  JTHETA=F1*COS(I1)*COS(D1)
  JPHI=F1*COS(I1)*SIN(D1)
C
C   COMPUTE MAGNETIC FIELD VECTOR (U,V,W) AT THE POINT (R,THETA,PHI)
C   DUE TO POINT DIPOLES AT (R1,THETA1(JY),PHI1(IX))
C
  PHI1=XORD+FLOAT(IX-1)*DXD
  SINP=SIN(PHI-PHI1)
  COSP=COS(PHI-PHI1)
  A=CT1T+ST1T*COSP
  B=SC1T-CS1T*COSP
  C=SINT*SINP
  R2=E-G*A
  R15=R2**1.5
  R25=R2**2.5
  XX=JR*(RD-RO*A)+JTHETA*RO*B-JPHI*RO*C
  ATHETA=-CS1T+SC1T*COSP
  BTHETA=-ST1T-CT1T*COSP
  CTHETA=COST*SINP
  APHI=-SINT1*SINP
  BPHI=COST1*SINP
  CPHI=COSP
C
  U1=-JR*A+JTHETA*B-JPHI*C
  U2=-3.0*XX*(RO-RD*A)
  U3=U1/R15
  U4=U2/R25
  U=U3+U4
C
  V1=-JR*ATHETA+JTHETA*BTHETA-JPHI*CTHETA
  V2=3.0*XX*RD*ATHETA
  V3=V1/R15
  V4=V2/R25
  V=V3+V4
C
  W1=-JR*APHI+JTHETA*BPHI-JPHI*CPHI
  W2=3.0*XX*RD*APHI
  W3=W1/R15
  W4=W2/R25
  W=W3+W4
C
C   CALCULATE THE COMPONENT OF THE ANOMALOUS FIELD IN THE DIRECTION
C   OF THE GEOMAGNETIC FIELD AT THE OBSERVATION POINT---I.E.,
C   ((U,V,W)*(UR,UTHETA,UPHI))*P(L) = TOTAL MAGNETIC FIELD
C
  UR=SIN(I)
  UTHETA=COS(I)*COS(D)
  UPHI=COS(I)*SIN(D)
C
  TMAG(L)=UR*U+UTHETA*V+UPHI*W
  YC=YC+P(L)*TMAG(L)
110 CONTINUE
C
  RETURN
C
  END
  SUBROUTINE MAGS2 (I,D,F1,I1,D1)
C
C*****
C   SUBROUTINE MAGS2 CALCULATES THE TOTAL MAGNETIC FIELD AT A SPHERICAL
C   OBSERVATION POINT (R,THETA,PHI) DUE TO A SPHERICAL ARRAY OF POINT
C   DIPOLES WITH CGS-SUSCEPTIBILITIES P(L) AT SOURCE GRID COORDINATES
C   (R1,THETA1,PHI1).
C*****

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C      COMMON XORD,YORD,DXD,DYD,NXD,NYD,RO,RD,E,G,COST,SINT,YC,THETA,PHI,
>P(3982),TMAG(3982),DF(361,44),S(7930153)
      REAL I,I1,JR,JTHETA,JPHI
      YC=0.0
      L=0
      DO 110 JY=1,NYD
        THETA1=YORD+FLOAT(JY-1)*DYD
        COST1=COS(THETA1)
        SINT1=SIN(THETA1)
        CT1T=COST1*COST
        ST1T=SINT1*SINT
        SC1T=SINT1*COST
        CS1T=COST1*SINT
C
C      DO 110 IX=1,NXD
        L=L+1
C
C      COMPUTE POINT DIPOLE POLARIZATION VECTOR IN SPHERICAL ORTHONORMAL
C      UNIT VECTORS (ER,ETHETA,EPhi) WITH SUSCEP(L)=1.0
C
        JR=F1*SIN(I1)
        JTHETA=F1*COS(I1)*COS(D1)
        JPHI=F1*COS(I1)*SIN(D1)
C
C      COMPUTE MAGNETIC FIELD VECTOR (U,V,W) AT THE POINT (R,THETA,PHI)
C      DUE TO POINT DIPOLES AT (R1,THETA1(JY),PHI1(IX))
C
        PHI1=XORD+FLOAT(IX-1)*DXD
        SINP=SIN(PHI-PHI1)
        COSP=COS(PHI-PHI1)
        A=CT1T+ST1T*COSP
        B=SC1T-CS1T*COSP
        C=SINT*SINP
        R2=E-G*A
        R15=R2**1.5
        R25=R2**2.5
        XX=JR*(RD-RO*A)+JTHETA*RO*B-JPHI*RO*C
        ATHETA=-CS1T+SC1T*COSP
        BTHETA=-ST1T-CT1T*COSP
        CTHETA=COST*SINP
        APhi=-SINT1*SINP
        BPhi=COST1*SINP
        CPhi=COSP
C
C      U1=-JR*A+JTHETA*B-JPHI*C
        U2=-3.0*XX*(RO-RD*A)
        U3=U1/R15
        U4=U2/R25
        U=U3+U4
C
C      V1=-JR*ATHETA+JTHETA*BTHETA-JPHI*CTHETA
        V2=3.0*XX*RD*ATHETA
        V3=V1/R15
        V4=V2/R25
        V=V3+V4
C
C      W1=-JR*APhi+JTHETA*BPhi-JPHI*CPhi
        W2=3.0*XX*RD*APhi
        W3=W1/R15
        W4=W2/R25
        W=W3+W4
C
C      CALCULATE THE COMPONENT OF THE ANOMALOUS FIELD IN THE DIRECTION
C      OF THE GEOMAGNETIC FIELD AT THE OBSERVATION POINT---I.E.,
C      ((U,V,W)*(UR,UTHETA,UPHI))*P(L) = TOTAL MAGNETIC FIELD
C
        UR=SIN(I)
        UTHETA=COS(I)*COS(D)
        UPHI=COS(I)*SIN(D)
C
        TMAG(L)=UR*U+UTHETA*V+UPHI*W
        YC=YC+P(L)*TMAG(L)
110 CONTINUE
C
      RETURN
C
      END
      SUBROUTINE GEOMAG (YEAR,ELV,THETA,PHI,HTHETA,HPhi,NTHETA,NPhi,NF)
      real fldd,fldo,incd,inco,decd,deco
      dimension fldd(44,181),fldo(44,361),incd(44,181),inco(44,361),
>      decd(44,181),deco(44,361)
      common /gmf/ fldd,fldo,incd,inco,decd,deco
C
C      *****
C      THIS SUBROUTINE CALCULATES THE MAGNITUDE, INCLINATION, AND
C      DECLINATION OF THE GEOMAGNETIC FIELD ON A GRID NTHETA BY
C      NPHI
C      *****

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C
C      THETA,PHI ** ORIGIN OF THE GRID (DEG.)
C      ELV ** ELEVATION OF GRID (KILO. ABOVE SEA LEVEL)
C      MTHETA,HPHI ** GRID SPACING (DEG.)
C      NTHETA,NPHI ** DIMENSIONS OF THE GRID
C      NF ** UNIT FILE WHICH WILL STORE THE FIELD
C
C      *****
C      SUBROUTINES USED
C      ** FIELDG ** (NASA)
C      ** FIELD ** (NASA)
C      ** WRITEB ** (SYSTEM)
C      *****
C
C      REAL F(361),INC(361),DEC(361)
C
C      write (6,*) ' '
C      if (nf .eq. 10) then
C        write (6,*) 'the following is the geomagnetic field'
C        write (6,*) 'over the observation grid'
C      elseif (nf .eq. 11) then
C        write (6,*) 'the following is the geomagnetic field'
C        write (6,*) 'over the source grid'
C      endif
C      write (6,*) ' '
C
C      LL=0
C      YYYYYY=THETA
C      XXXXXX=PHI
C
C      DO 120 I=1,NTHETA
C        PHI=XXXXXX
C        DO 110 J=1,NPHI
C
C          CALL FIELDG (THETA,PHI,ELV,YEAR,50,LL,X,Y,Z,F(J))
C
C          H=SQRT(X**2+Y**2)
C          INC(J)=ATAN2(Z,H)
C          DEC(J)=ATAN2(Y,X)
C          PHI=PHI+HPHI
C
C110      CONTINUE
C
C----- change 6 to nf in write statement
C          if separate files for g.m.f.o.o.
C          and g.m.f.o.s is wanted. don't forget
C          to also use open statements.
C
C      WRITE(6,9981) (F(L),L=1,NPHI)
C      WRITE(6,9981) (INC(L),L=1,NPHI)
C      WRITE(6,9981) (DEC(L),L=1,NPHI)
C      write (67,9981) (f(l),l=1,nphi)
C      write (68,9981) ((inc(l)*57.295828),l=1,nphi)
C      write (69,9981) ((dec(l)*57.295828),l=1,nphi)
C9981  format (4(1x,f19.9))
C
C      if (nf .eq. 11) then
C        do 710 l=1,nphi
C          fldd(l,l)=f(l)
C          incd(l,l)=inc(l)
C          decd(l,l)=dec(l)
C710      continue
C      else if (nf .eq. 10) then
C        do 720 l=1,nphi
C          fldo(l,l)=f(l)
C          incd(l,l)=inc(l)
C          deco(l,l)=dec(l)
C720      continue
C      endif
C      THETA=THETA+MTHETA
C120  CONTINUE
C
C      PHI=XXXXXX
C      THETA=YYYYYY
C      RETURN
C
C      END
C      SUBROUTINE FIELDG (DLAT,DLONG,ALT,TM,NMX,L,X,Y,Z,F)
C
C      *****
C      FOR DOCUMENTATION OF THIS SUBROUTINE AND SUBROUTINE FIELD SEE :
C      NATIONAL SPACE SCIENCE DATA CENTER'S PUBLICATION
C      **COMPUTATION OF THE MAIN GEOMAGNETIC FIELD
C      FROM SPHERICAL HARMONIC EXPANSIONS**
C      DATA USERS' NOTE, NSSDC 68-11, MAY 1968
C      GODDARD SPACE FLIGHT CENTER, GREENBELT, MD.
C      *****
C
C      DLAT ** LATITUDE IN DEGREES POSITIVE NORTH

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C      DLONG ** LONGITUDE IN DEGREES POSITIVE EAST
C      ALT ** ELEVATION IN KM (POSITIVE ABOVE, NEGATIVE BELOW
C      EARTH'S SURFACE)
C      TM ** EPOCH IN YEARS
C      NMK ** SET TO INTEGER GREATER THAN DEGREE OF EXPANSION
C      L ** SET TO 1 ON INITIAL DUMMY CALL, SET TO 0 ON SUBSEQUENT
C      CALLS
C
C      SUBROUTINE RETURNS GEOMAGNETIC FIELD DIRECTIONS (X,Y,Z), POSI-
C      TIVE NORTH, EAST AND DOWN, RESPECTIVELY, AND MAGNITUDE OF TOTAL
C      FIELD, F---ALL VALUES ARE IN GAMMAS
C
C      EQUIVALENCE (SHMIT(1,1),TG(1,1))
C      COMMON /NASA/ TG(55,55)
C      COMMON /FLDCOM/ CPH,SPH,R,CT,ST,BT,BP,BR,B
C      COMMON /MAX/ NMAX
C      DIMENSION G(55,55), GT(55,55), SHMIT(55,55), AID(55), GTT(55,55)
C      DATA A/0./
C
C      TLAST=0.0
C
C      IF (A.EQ.6378.16) IF(L) 210,100,110
C
C      A=6378.16
C      FLAT=1.-1./298.25
C      A2=A**2
C      A4=A**4
C      B2=(A*FLAT)**2
C      A2B2=A2*(1.-FLAT**2)
C      A4B4=A4*(1.-FLAT**4)
C      IF (L) 160,160,110
C100 IF (TM-TLAST) 190,210,190
C110 READ (3,260) J,K,TZERO,(AID(I),I=1,11)
C      L=0
C      WRITE(6,270) J,K,TZERO,(AID(I),I=1,11)
C      MAXN=0
C      TEMP=0.
C120 READ (3,280) N,M,GNM,HNM,GTNM,HTNM,GTTNM,HTTNM
C      IF (N.LE.0) GO TO 130
C      MAXN=(MAX0(N,MAXN))
C      G(N,M)=GNM
C      GT(N,M)=GTNM
C      GTT(N,M)=GTTNM
C      TEMP=AMAX1(TEMP,ABS(GTNM))
C      IF (M.EQ.1) GO TO 120
C      G(M-1,N)=HNM
C      GT(M-1,N)=HTNM
C      GTT(M-1,N)=HTTNM
C      GO TO 120
C130 continue
C      rewind (3)
C130 WRITE(6,290)
C      DO 150 N=2,MAXN
C      DO 150 M=1,N
C      MI=M-1
C      IF (M.EQ.1) GO TO 140
C      WRITE(6,300) N,M,G(N,M),G(MI,N),GT(N,M),GT(MI,N),GTT(N,M),GTT(
C1  MI,N)
C      GO TO 150
C140 WRITE(6,310) N,M,G(N,M),GT(N,M),GTT(N,M)
C150 CONTINUE
C      WRITE (6,320)
C      IF (TEMP.EQ.0.) L=-1
C160 IF (K.NE.0) GO TO 190
C      SHMIT(1,1)=-1.
C      DO 170 N=2,MAXN
C      SHMIT(N,1)=SHMIT(N-1,1)*FLOAT(2*N-3)/FLOAT(N-1)
C      SHMIT(1,N)=0.
C      JJ=2
C      DO 170 M=2,N
C      SHMIT(N,M)=SHMIT(N,M-1)*SQRT(FLOAT((N-M+1)*JJ)/FLOAT(N+M-2))
C      SHMIT(M-1,N)=SHMIT(N,M)
C170 JJ=1
C      DO 180 N=2,MAXN
C      DO 180 M=1,N
C      G(N,M)=G(N,M)*SHMIT(N,M)
C      GT(N,M)=GT(N,M)*SHMIT(N,M)
C      GTT(N,M)=GTT(N,M)*SHMIT(N,M)
C      IF (M.EQ.1) GO TO 180
C      G(M-1,N)=G(M-1,N)*SHMIT(M-1,N)
C      GT(M-1,N)=GT(M-1,N)*SHMIT(M-1,N)
C      GTT(M-1,N)=GTT(M-1,N)*SHMIT(M-1,N)
C180 CONTINUE
C190 T=TM-TZERO
C      DO 200 N=1,MAXN
C      DO 200 M=1,N
C      TG(N,M)=G(N,M)+T*(GT(N,M)+GTT(N,M)*T)
C      IF (M.EQ.1) GO TO 200
C      TG(M-1,N)=G(M-1,N)+T*(GT(M-1,N)+GTT(M-1,N)*T)

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200 CONTINUE
    TLAST=TM
210 DLATR=DLAT/57.2957795
    SINLA=SIN(DLATR)
    RLONG=DLONG/57.2957795
    CPH=COS(RLONG)
    SPH=SIN(RLONG)
    IF (J.EQ.0) GO TO 220
    R=ALT+6371.0
    CT=SINLA
    GO TO 230
220 SINLA2=SINLA**2
    COSLA2=1.-SINLA2
    DEN2=A2-A2B2*SINLA2
    DEN=SQRT(DEN2)
    FAC=((ALT*DEN)+A2)/((ALT*DEN)+B2)**2
    CT=SINLA/SQRT(FAC*COSLA2+SINLA2)
    R=SQRT(ALT*(ALT+2.*DEN)+(A4-A4B4*SINLA2)/DEN2)
230 ST=SQRT(1.-CT**2)
    NMAX=MIN0(NMX,MAXN)
C
    CALL FIELD
C
    Y=BP
    F=B
    IF (J) 240,250,240
240 X=-BT
    Z=-BR
    RETURN
C
C    TRANSFORMS FIELD TO GEODETIC DIRECTIONS
C
250 SIND=SINLA*ST-SQRT(COSLA2)*CT
    COSD=SQRT(1.0-SIND**2)
    X=-BT*COSD-BR*SIND
    Z=BT*SIND-BR*COSD
    RETURN
C
260 FORMAT (2I1,1X,F6.1,10A6,A3)
270 FORMAT (2I3,5X,6HEPOCH ,F7.1,5X,10A6,A3)
280 FORMAT (2I3,6F11.4)
290 FORMAT(6H0 N M,6X,1HG,10X,1HH,9X,2HGT,9X,2HHT,8X,3HGT//
1)
300 FORMAT (2I3,6F11.4)
310 FORMAT (2I3,F11.4,11X,F11.4,11X,F11.4)
320 FORMAT (///)
C
    END
C
C
C    SUBROUTINE FIELD
C
    COMMON /NASA/ G(55,55)
    COMMON /FLDCOM/ CPH,SPH,R,CT,ST,BT,BP,BR,B
    COMMON /MAX/ NMAX
    DIMENSION P(55,55), DP(55,55), CONST(55,55), SP(55), CP(55),
> FN(55), FM(55)
    DATA P(1,1)/0./
C
    IF (P(1,1).EQ.1.0) GO TO 120
    P(1,1)=1.
    DP(1,1)=0.
    SP(1)=0.
    CP(1)=1.
    DO 110 N=2,18
        FN(N)=N
    DO 110 M=1,N
        FM(M)=M-1
110 CONST(N,M)=FLOAT((N-2)**2-(M-1)**2)/FLOAT((2*N-3)*(2*N-5))
120 SP(2)=SPH
    CP(2)=CPH
    DO 130 M=3,NMAX
        SP(M)=SP(2)*CP(M-1)+CP(2)*SP(M-1)
130 CP(M)=CP(2)*CP(M-1)-SP(2)*SP(M-1)
    AOR=6371.0/R
    AR=AOR**2
    BT=0.
    BP=0.
    BR=0.
    DO 190 N=2,NMAX
        AR=AOR*AR
    DO 190 M=1,N
        IF (N-M) 150,140,150
140 P(N,M)=ST*P(N-1,M-1)
    DP(N,M)=ST*DP(N-1,M-1)+CT*P(N-1,M-1)
    GO TO 160
150 P(N,M)=CT*P(N-1,M)-CONST(N,M)*P(N-2,M)
    DP(N,M)=CT*DP(N-1,M)-ST*P(N-1,M)-CONST(N,M)*DP(N-2,M)
160 PAR=P(N,M)*AR
    IF (M.EQ.1) GO TO 170

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      TEMP=G(N,M)*CP(M)+G(M-1,N)*SP(M)
      BP=BP-(G(N,M)*SP(M)-G(M-1,N)*CP(M))*FM(M)*PAR
      GO TO 180
170    TEMP=G(N,M)*CP(M)
      BP=BP-(G(N,M)*SP(M))*FM(M)*PAR
180    BT=BT+TEMP*DP(N,M)*AR
190    BR=BR-TEMP*FN(N)*PAR
      BP=BP/ST
      B=SQRT(BT*BT+BP*BP+BR*BR)
      RETURN
C
      END
      SUBROUTINE SPPCO(AP,N,RCOND,Z,INFO)
      INTEGER N,INFO
      REAL AP(1),Z(1)
      REAL RCOND
C
C     SPPCO FACTORS A REAL SYMMETRIC POSITIVE DEFINITE MATRIX
C     STORED IN PACKED FORM
C     AND ESTIMATES THE CONDITION OF THE MATRIX.
C
C     IF RCOND IS NOT NEEDED, SPPFA IS SLIGHTLY FASTER.
C     TO SOLVE  $A \cdot X = B$ , FOLLOW SPPCO BY SPPSL.
C     TO COMPUTE  $INVERSE(A) \cdot C$ , FOLLOW SPPCO BY SPPSL.
C     TO COMPUTE  $DETERMINANT(A)$ , FOLLOW SPPCO BY SPPDI.
C     TO COMPUTE  $INVERSE(A)$ , FOLLOW SPPCO BY SPPDI.
C
      ON ENTRY
C
C     AP      REAL (N*(N+1)/2)
C             THE PACKED FORM OF A SYMMETRIC MATRIX A. THE
C             COLUMNS OF THE UPPER TRIANGLE ARE STORED SEQUENTIALLY
C             IN A ONE-DIMENSIONAL ARRAY OF LENGTH  $N*(N+1)/2$ .
C             SEE COMMENTS BELOW FOR DETAILS.
C
C     N      INTEGER
C             THE ORDER OF THE MATRIX A.
C
      ON RETURN
C
C     AP      AN UPPER TRIANGULAR MATRIX R, STORED IN PACKED
C             FORM, SO THAT  $A = TRANS(R) \cdot R$ .
C             IF INFO.NE.0, THE FACTORIZATION IS NOT COMPLETE.
C
C     RCOND   REAL
C             AN ESTIMATE OF THE RECIPROCAL CONDITION OF A.
C             FOR THE SYSTEM  $A \cdot X = B$ , RELATIVE PERTURBATIONS
C             IN A AND B OF SIZE EPSILON MAY CAUSE
C             RELATIVE PERTURBATIONS IN X OF SIZE  $EPSILON/RCOND$ .
C             IF RCOND IS SO SMALL THAT THE LOGICAL EXPRESSION
C              $1.0 + RCOND .EQ. 1.0$ 
C             IS TRUE, THEN A MAY BE SINGULAR TO WORKING
C             PRECISION. IN PARTICULAR, RCOND IS ZERO IF
C             EXACT SINGULARITY IS DETECTED OR THE ESTIMATE
C             UNDERFLOWS. IF INFO.NE.0, RCOND IS UNCHANGED.
C
C     Z      REAL(N)
C             A WORK VECTOR WHOSE CONTENTS ARE USUALLY UNIMPORTANT.
C             IF A IS SINGULAR TO WORKING PRECISION, THEN Z IS
C             AN APPROXIMATE NULL VECTOR IN THE SENSE THAT
C              $NORM(A \cdot Z) = RCOND \cdot NORM(A) \cdot NORM(Z)$ .
C             IF INFO.NE.0, Z IS UNCHANGED.
C
C     INFO    INTEGER
C             = 0 FOR NORMAL RETURN.
C             = K SIGNALS AN ERROR CONDITION. THE LEADING MINOR
C               OF ORDER K IS NOT POSITIVE DEFINITE.
C
      PACKED STORAGE
C
C     THE FOLLOWING PROGRAM SEGMENT WILL PACK THE UPPER
C     TRIANGLE OF A SYMMETRIC MATRIX.
C
C       K = 0
C       DO 20 J = 1, N
C         DO 10 I = 1, J
C           K = K + 1
C           AP(K) = A(I,J)
C         10 CONTINUE
C       20 CONTINUE
C
      LINPACK. THIS VERSION DATED 08/14/78.
      CLEVE MOLER, UNIVERSITY OF NEW MEXICO, ARGONNE NATIONAL LAB.
C
      SUBROUTINES AND FUNCTIONS
C
      LINPACK SPPFA
      BLAS SAXPY,SDOT,SSCAL,SASUM
      FORTRAN ABS,AMAX1,REAL,SIGN
C
      INTERNAL VARIABLES

```

```

C      REAL SDOT,EK,T,WK,WKM
C      REAL ANORM,S,SASUM,SM,YNORM
C      INTEGER I,IJ,J,JM1,J1,K,KB,KJ,KK,KP1
C
C      FIND NORM OF A
C
C      J1 = 1
C      DO 30 J = 1, N
C          Z(J) = SASUM(J,AP(J1),1)
C          IJ = J1
C          J1 = J1 + J
C          JM1 = J - 1
C          IF (JM1 .LT. 1) GO TO 20
C          DO 10 I = 1, JM1
C              Z(I) = Z(I) + ABS(AP(IJ))
C              IJ = IJ + 1
C      10  CONTINUE
C      20  CONTINUE
C      30  CONTINUE
C      ANORM = 0.0E0
C      DO 40 J = 1, N
C          ANORM = AMAX1 (ANORM,Z(J))
C      40  CONTINUE
C
C      FACTOR
C
C      CALL SPPFA (AP,N,INFO)
C      IF (INFO .NE. 0) GO TO 180
C
C      RCOND = 1/(NORM(A)*(ESTIMATE OF NORM(INVERSE(A)))) .
C      ESTIMATE = NORM(Z)/NORM(Y) WHERE A*Z = Y AND A*Y = E .
C      THE COMPONENTS OF E ARE CHOSEN TO CAUSE MAXIMUM LOCAL
C      GROWTH IN THE ELEMENTS OF W WHERE TRANS(R)*W = E .
C      THE VECTORS ARE FREQUENTLY RESCALED TO AVOID OVERFLOW.
C
C      SOLVE TRANS(R)*W = E
C
C      EK = 1.0E0
C      DO 50 J = 1, N
C          Z(J) = 0.0E0
C      50  CONTINUE
C      KK = 0
C      DO 110 K = 1, N
C          KK = KK + K
C          IF (Z(K) .NE. 0.0E0) EK = SIGN(EK,-Z(K))
C          IF (ABS(EK-Z(K)) .LE. AP(KK)) GO TO 60
C          S = AP(KK)/ABS(EK-Z(K))
C          CALL SSCAL(N,S,Z,1)
C          EK = S*EK
C      60  CONTINUE
C          WK = EK - Z(K)
C          WKM = -EK - Z(K)
C          S = ABS(WK)
C          SM = ABS(WKM)
C          WK = WK/AP(KK)
C          WKM = WKM/AP(KK)
C          KP1 = K + 1
C          KJ = KK + K
C          IF (KP1 .GT. N) GO TO 100
C          DO 70 J = KP1, N
C              SM = SM + ABS(Z(J)+WKM*AP(KJ))
C              Z(J) = Z(J) + WK*AP(KJ)
C              S = S + ABS(Z(J))
C              KJ = KJ + J
C      70  CONTINUE
C          IF (S .GE. SM) GO TO 90
C          T = WKM - WK
C          WK = WKM
C          KJ = KK + K
C          DO 80 J = KP1, N
C              Z(J) = Z(J) + T*AP(KJ)
C              KJ = KJ + J
C      80  CONTINUE
C      90  CONTINUE
C      100 CONTINUE
C          Z(K) = WK
C      110 CONTINUE
C          S = 1.0E0/SASUM(N,Z,1)
C          CALL SSCAL(N,S,Z,1)
C
C      SOLVE R*Y = W
C
C      DO 130 KB = 1, N
C          K = N + 1 - KB
C          IF (ABS(Z(K)) .LE. AP(KK)) GO TO 120
C          S = AP(KK)/ABS(Z(K))
C          CALL SSCAL(N,S,Z,1)
C      120 CONTINUE

```

```

      Z(K) = Z(K)/AP(KK)
      KK = KK - K
      T = -Z(K)
      CALL SAXPY(K-1,T,AP(KK+1),1,Z(1),1)
130  CONTINUE
      S = 1.0E0/SASUM(N,Z,1)
      CALL SSCAL(N,S,Z,1)
C
C      YNORM = 1.0E0
C
C      SOLVE TRANS(R)*V = Y
C
      DO 150 K = 1, N
        Z(K) = Z(K) - SDOT(K-1,AP(KK+1),1,Z(1),1)
        KK = KK + K
        IF (ABS(Z(K)) .LE. AP(KK)) GO TO 140
        S = AP(KK)/ABS(Z(K))
        CALL SSCAL(N,S,Z,1)
        YNORM = S*YNORM
140  CONTINUE
        Z(K) = Z(K)/AP(KK)
150  CONTINUE
      S = 1.0E0/SASUM(N,Z,1)
      CALL SSCAL(N,S,Z,1)
      YNORM = S*YNORM
C
C      SOLVE R*Z = V
C
      DO 170 KB = 1, N
        K = N + 1 - KB
        IF (ABS(Z(K)) .LE. AP(KK)) GO TO 160
        S = AP(KK)/ABS(Z(K))
        CALL SSCAL(N,S,Z,1)
        YNORM = S*YNORM
160  CONTINUE
        Z(K) = Z(K)/AP(KK)
        KK = KK - K
        T = -Z(K)
        CALL SAXPY(K-1,T,AP(KK+1),1,Z(1),1)
170  CONTINUE
      MAKE ZNORM = 1.0
      S = 1.0E0/SASUM(N,Z,1)
      CALL SSCAL(N,S,Z,1)
      YNORM = S*YNORM
C
      IF (ANORM .NE. 0.0E0) RCOND = YNORM/ANORM
      IF (ANORM .EQ. 0.0E0) RCOND = 0.0E0
180  CONTINUE
      RETURN
      END
      SUBROUTINE SPPFA(AP,N,INFO)
      INTEGER N,INFO
      REAL AP(1)
C
C      SPPFA FACTORS A REAL SYMMETRIC POSITIVE DEFINITE MATRIX
C      STORED IN PACKED FORM.
C
C      SPPFA IS USUALLY CALLED BY SPPCO, BUT IT CAN BE CALLED
C      DIRECTLY WITH A SAVING IN TIME IF RCOND IS NOT NEEDED.
C      (TIME FOR SPPCO) = (1 + 18/N)*(TIME FOR SPPFA) .
C
      ON ENTRY
C
C      AP      REAL (N*(N+1)/2)
C              THE PACKED FORM OF A SYMMETRIC MATRIX A . THE
C              COLUMNS OF THE UPPER TRIANGLE ARE STORED SEQUENTIALLY
C              IN A ONE-DIMENSIONAL ARRAY OF LENGTH N*(N+1)/2 .
C              SEE COMMENTS BELOW FOR DETAILS.
C
C      N      INTEGER
C              THE ORDER OF THE MATRIX A .
C
      ON RETURN
C
C      AP      AN UPPER TRIANGULAR MATRIX R , STORED IN PACKED
C              FORM, SO THAT A = TRANS(R)*R .
C
C      INFO    INTEGER
C              = 0 FOR NORMAL RETURN.
C              = K IF THE LEADING MINOR OF ORDER K IS NOT
C                  POSITIVE DEFINITE.
C
      PACKED STORAGE
C
      THE FOLLOWING PROGRAM SEGMENT WILL PACK THE UPPER
      TRIANGLE OF A SYMMETRIC MATRIX.
C
      K = 0
      DO 20 J = 1, N

```

```

C          DO 10 I = 1, J
C              K = K + 1
C              AP(K) = A(I,J)
C          10  CONTINUE
C          20  CONTINUE
C
C  LINPACK. THIS VERSION DATED 08/14/78 .
C  CLEVE MOLER, UNIVERSITY OF NEW MEXICO, ARGONNE NATIONAL LAB.
C
C  SUBROUTINES AND FUNCTIONS
C
C  BIAS SDOT
C  FORTRAN SQRT
C
C  INTERNAL VARIABLES
C
C  REAL SDOT,T
C  REAL S
C  INTEGER J,JJ,JM1,K,KJ,KK
C  BEGIN BLOCK WITH ...EXITS TO 40
C
C          JJ = 0
C          DO 30 J = 1, N
C              INFO = J
C              S = 0.0E0
C              JM1 = J - 1
C              KJ = JJ
C              KK = 0
C              IF (JM1 .LT. 1) GO TO 20
C              DO 10 K = 1, JM1
C                  KJ = KJ + 1
C                  T = AP(KJ) - SDOT(K-1,AP(KK+1),1,AP(JJ+1),1)
C                  KK = KK + K
C                  T = T/AP(KK)
C                  AP(KJ) = T
C                  S = S + T*T
C              10  CONTINUE
C              20  CONTINUE
C                  JJ = JJ + J
C                  S = AP(JJ) - S
C          .....EXIT
C              IF (S .LE. 0.0E0) GO TO 40
C              AP(JJ) = SQRT(S)
C          30  CONTINUE
C              INFO = 0
C          40  CONTINUE
C              RETURN
C              END
C              SUBROUTINE SAXPY (N,SA,SX,INCX,SY,INCY)
C
C -----
C  COMPUTER          - CDC/SINGLE
C
C  LATEST REVISION   - JANUARY 1, 1978
C
C  PURPOSE           - COMPUTE A CONSTANT TIMES A VECTOR PLUS
C                     A VECTOR, ALL SINGLE PRECISION
C
C  USAGE            - CALL SAXPY (N,SA,SX,INCX,SY,INCY)
C
C  ARGUMENTS        N - LENGTH OF VECTORS X AND Y. (INPUT)
C                     SA - REAL SCALAR. (INPUT)
C                     SX - REAL VECTOR OF LENGTH MAX(N*IABS(INCX),1).
C                         (INPUT)
C                     INCX - DISPLACEMENT BETWEEN ELEMENTS OF SX. (INPUT)
C                         X(I) IS DEFINED TO BE..
C                         SX(1+(I-1)*INCX) IF INCX.GE.0 OR
C                         SX(1+(I-N)*INCX) IF INCX.LT.0.
C                     SY - REAL VECTOR OF LENGTH MAX(N*IABS(INCY),1).
C                         (INPUT/OUTPUT)
C                         SAXPY REPLACES Y(I) WITH SA*X(I)+Y(I)
C                         FOR I=1,...,N.
C                         X(I) AND Y(I) REFER TO SPECIFIC ELEMENTS
C                         OF SX AND SY, RESPECTIVELY. SEE INCX AND
C                         INCY ARGUMENT DESCRIPTIONS.
C                     INCY - DISPLACEMENT BETWEEN ELEMENTS OF SY. (INPUT)
C                         Y(I) IS DEFINED TO BE..
C                         SY(1+(I-1)*INCY) IF INCY.GE.0 OR
C                         SY(1+(I-N)*INCY) IF INCY.LT.0.
C
C  PRECISION/HARDWARE - SINGLE/ALL
C
C  REQD. IMSL ROUTINES - NONE REQUIRED
C
C  NOTATION          - INFORMATION ON SPECIAL NOTATION AND
C                     CONVENTIONS IS AVAILABLE IN THE MANUAL
C                     INTRODUCTION OR THROUGH IMSL ROUTINE UHELP
C

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C
C-----
C
C                      SPECIFICATIONS FOR ARGUMENTS
C  INTEGER             N, INCX, INCY
C  REAL                SX(1), SY(1), SA
C                      SPECIFICATIONS FOR LOCAL VARIABLES
C  INTEGER             I, IX, IY, M, MP1, NS
C                      FIRST EXECUTABLE STATEMENT
C  IF (N.LE.0.OR.SA.EQ.0.EO) RETURN
C  IF (INCX.EQ.INCY) IF (INCX-1) 5,15,35
C  5 CONTINUE
C                      CODE FOR NONEQUAL OR NONPOSITIVE
C                      INCREMENTS.
C
C  IX = 1
C  IY = 1
C  IF (INCX.LT.0) IX = (-N+1)*INCX+1
C  IF (INCY.LT.0) IY = (-N+1)*INCY+1
C  DO 10 I=1,N
C    SY(IY) = SY(IY)+SA*SX(IX)
C    IX = IX+INCX
C    IY = IY+INCY
C  10 CONTINUE
C  RETURN
C                      CODE FOR BOTH INCREMENTS EQUAL TO 1
C                      CLEAN-UP LOOP SO REMAINING VECTOR
C                      LENGTH IS A MULTIPLE OF 4.
C
C  15 M = N-(N/4)*4
C  IF (M.EQ.0) GO TO 25
C  DO 20 I=1,M
C    SY(I) = SY(I)+SA*SX(I)
C  20 CONTINUE
C  IF (N.LT.4) RETURN
C  25 MP1 = M+1
C  DO 30 I=MP1,N,4
C    SY(I) = SY(I)+SA*SX(I)
C    SY(I+1) = SY(I+1)+SA*SX(I+1)
C    SY(I+2) = SY(I+2)+SA*SX(I+2)
C    SY(I+3) = SY(I+3)+SA*SX(I+3)
C  30 CONTINUE
C  RETURN
C                      CODE FOR EQUAL, POSITIVE, NONUNIT
C                      INCREMENTS.
C
C  35 CONTINUE
C  NS = N*INCX
C  DO 40 I=1,NS,INCX
C    SY(I) = SA*SX(I)+SY(I)
C  40 CONTINUE
C  RETURN
C  END
C  REAL FUNCTION SDOT (N,SX,INCX,SY,INCY)
C
C-----
C
C  COMPUTER           - CDC/SINGLE
C
C  LATEST REVISION    - JANUARY 1, 1978
C
C  PURPOSE            - COMPUTE SINGLE PRECISION DOT PRODUCT
C
C  USAGE              - FUNCTION SDOT (N,SX,INCX,SY,INCY)
C
C  ARGUMENTS          SDOT - SUM FROM I=1 TO N OF X(I)*Y(I). (OUTPUT)
C                      X(I) AND Y(I) REFER TO SPECIFIC ELEMENTS
C                      OF SX AND SY, RESPECTIVELY. SEE INCX AND
C                      INCY ARGUMENT DESCRIPTIONS.
C                      N - LENGTH OF VECTORS X AND Y. (INPUT)
C                      SX - REAL VECTOR OF LENGTH MAX(N*ABS(INCX),1).
C                          (INPUT)
C                      INCX - DISPLACEMENT BETWEEN ELEMENTS OF SX. (INPUT)
C                          X(I) IS DEFINED TO BE..
C                          SX(1+(I-1)*INCX) IF INCX.GE.0 OR
C                          SX(1+(I-N)*INCX) IF INCX.LT.0.
C                      SY - REAL VECTOR OF LENGTH MAX(N*ABS(INCY),1).
C                          (INPUT)
C                      INCY - DISPLACEMENT BETWEEN ELEMENTS OF SY. (INPUT)
C                          Y(I) IS DEFINED TO BE..
C                          SY(1+(I-1)*INCY) IF INCY.GE.0 OR
C                          SY(1+(I-N)*INCY) IF INCY.LT.0.
C
C  PRECISION/HARDWARE - SINGLE/ALL
C
C  REQD. IMSL ROUTINES - NONE REQUIRED
C

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C
C-----
C
C                    SPECIFICATIONS FOR ARGUMENTS
C  INTEGER            N, INCX, INCY
C  REAL               SX(1), SY(1)
C
C                    SPECIFICATIONS FOR LOCAL VARIABLES
C  INTEGER            I, M, MP1, NS, IX, IY
C
C  FIRST EXECUTABLE STATEMENT
C
C  SDOT = 0.0E0
C  IF (N.LE.0) RETURN
C  IF (INCX.EQ.INCY) IF (INCX-1) 5,15,35
C 5 CONTINUE
C
C                    CODE FOR UNEQUAL INCREMENTS OR
C                    NONPOSITIVE INCREMENTS.
C
C  IX = 1
C  IY = 1
C  IF (INCX.LT.0) IX = (-N+1)*INCX+1
C  IF (INCY.LT.0) IY = (-N+1)*INCY+1
C  DO 10 I=1,N
C    SDOT = SDOT+SX(I)*SY(IY)
C    IX = IX+INCX
C    IY = IY+INCY
C 10 CONTINUE
C  RETURN
C
C                    CODE FOR BOTH INCREMENTS EQUAL TO 1
C                    CLEAN-UP LOOP SO REMAINING VECTOR
C                    LENGTH IS A MULTIPLE OF 5.
C
C 15 M = N-(N/5)*5
C  IF (M.EQ.0) GO TO 25
C  DO 20 I=1,M
C    SDOT = SDOT+SX(I)*SY(I)
C 20 CONTINUE
C  IF (N.LT.5) RETURN
C 25 MP1 = M+1
C  DO 30 I=MP1,N,5
C    SDOT = SDOT+SX(I)*SY(I)+SX(I+1)*SY(I+1)+SX(I+2)*SY(I+2)+SX(I
C 1  +3)*SY(I+3)+SX(I+4)*SY(I+4)
C 30 CONTINUE
C  RETURN
C
C                    CODE FOR POSITIVE EQUAL INCREMENTS
C                    .NE.1.
C
C 35 CONTINUE
C  NS = N*INCX
C  DO 40 I=1,NS,INCX
C    SDOT = SDOT+SX(I)*SY(I)
C 40 CONTINUE
C  RETURN
C  END
C  SUBROUTINE SSCAL (N,SA,SX,INCX)
C
C-----
C
C  COMPUTER           - CDC/SINGLE
C
C  LATEST REVISION    - JANUARY 1, 1978
C
C  PURPOSE            - COMPUTE A SINGLE PRECISION CONSTANT
C                    TIMES A SINGLE PRECISION VECTOR
C
C  USAGE              - CALL SSCAL (N,SA,SX,INCX)
C
C  ARGUMENTS          N - LENGTH OF VECTOR X. (INPUT)
C                    SA - REAL SCALAR. (INPUT)
C                    SX - REAL VECTOR OF LENGTH N*INCX. (INPUT/OUTPUT)
C                      SSCAL REPLACES X(I) WITH SA*X(I) FOR
C                      I=1,...,N.
C                      X(I) REFERS TO A SPECIFIC ELEMENT OF SX.
C                      SEE INCX ARGUMENT DESCRIPTION.
C                    INCX - DISPLACEMENT BETWEEN ELEMENTS OF SX. (INPUT)
C                      X(I) IS DEFINED TO BE SX(1+(I-1)*INCX).
C                      INCX MUST BE GREATER THAN ZERO.
C
C  PRECISION/HARDWARE - SINGLE/ALL
C
C  REQD. IMSL ROUTINES - NONE REQUIRED
C
C  NOTATION           - INFORMATION ON SPECIAL NOTATION AND
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C
C-----
C
C                SPECIFICATIONS FOR ARGUMENTS
C      INTEGER      INCX,N
C      REAL          SA,SX(1)
C                SPECIFICATIONS FOR LOCAL VARIABLES
C      INTEGER      I,M,MP1,NS
C                FIRST EXECUTABLE STATEMENT
C      IF (N.LE.0) RETURN
C      IF (INCX.EQ.1) GO TO 10
C
C                CODE FOR INCREMENTS NOT EQUAL TO 1.
C      NS = N*INCX
C      DO 5 I=1,NS,INCX
C        SX(I) = SA*SX(I)
C      5 CONTINUE
C      RETURN
C
C                CODE FOR INCREMENTS EQUAL TO 1.
C                CLEAN-UP LOOP SO REMAINING VECTOR
C                LENGTH IS A MULTIPLE OF 5.
C      10 M = N-(N/5)*5
C      IF (M.EQ.0) GO TO 20
C      DO 15 I=1,M
C        SX(I) = SA*SX(I)
C      15 CONTINUE
C      IF (N.LT.5) RETURN
C      20 MP1 = M+1
C      DO 25 I=MP1,N,5
C        SX(I) = SA*SX(I)
C        SX(I+1) = SA*SX(I+1)
C        SX(I+2) = SA*SX(I+2)
C        SX(I+3) = SA*SX(I+3)
C        SX(I+4) = SA*SX(I+4)
C      25 CONTINUE
C      RETURN
C      END
C      REAL FUNCTION SASUM (N,SX,INCX)
C
C-----
C
C      COMPUTER      - CDC/SINGLE
C
C      LATEST REVISION - JANUARY 1, 1978
C
C      PURPOSE      - COMPUTE SINGLE PRECISION SUM OF ABSOLUTE
C                    VALUES
C
C      USAGE        - FUNCTION SASUM (N,SX,INCX)
C
C      ARGUMENTS    SASUM - SUM FROM I=1 TO N OF ABS(X(I)). (OUTPUT)
C                    X(I) REFERS TO A SPECIFIC ELEMENT OF SX.
C                    SEE INCX ARGUMENT DESCRIPTION.
C                    N      - LENGTH OF VECTOR X. (INPUT)
C                    SX     - REAL VECTOR OF LENGTH N*INCX. (INPUT)
C                    INCX   - DISPLACEMENT BETWEEN ELEMENTS OF SX. (INPUT)
C                    X(I) IS DEFINED TO BE SX(1+(I-1)*INCX).
C                    INCX MUST BE GREATER THAN ZERO.
C
C      PRECISION/HARDWARE - SINGLE/ALL
C
C      REQD. IMSL ROUTINES - NONE REQUIRED
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C
C-----
C
C                SPECIFICATIONS FOR ARGUMENTS
C      INTEGER      N,INCX
C      REAL          SX(1)
C                SPECIFICATIONS FOR LOCAL VARIABLES
C      INTEGER      I,M,MP1,NS
C                FIRST EXECUTABLE STATEMENT
C      SASUM = 0.0E0
C      IF (N.LE.0) RETURN
C      IF (INCX.EQ.1) GO TO 10

```



```

C                                     CODE FOR INCREMENTS NOT EQUAL TO 1.
      NS = N*INCX
      DO 5 I=1,NS,INCX
        SASUM = SASUM+ABS(SX(I))
5     CONTINUE
      RETURN

C                                     CODE FOR INCREMENTS EQUAL TO 1.
C                                     CLEAN-UP LOOP SO REMAINING VECTOR
C                                     LENGTH IS A MULTIPLE OF 6.
10    M = N-(N/6)*6
      IF (M.EQ.0) GO TO 20
      DO 15 I=1,M
        SASUM = SASUM+ABS(SX(I))
15    CONTINUE
      IF (N.LT.6) RETURN
20    MP1 = M+1
      DO 25 I=MP1,N,6
        SASUM = SASUM+ABS(SX(I))+ABS(SX(I+1))+ABS(SX(I+2))+ABS(SX(I
1      +3))+ABS(SX(I+4))+ABS(SX(I+5))
25    CONTINUE
      RETURN
      END
      SUBROUTINE SPPSL(AP,N,B)
      INTEGER N
      REAL AP(1),B(1)

C
C     SPPSL SOLVES THE REAL SYMMETRIC POSITIVE DEFINITE SYSTEM
C     A * X = B
C     USING THE FACTORS COMPUTED BY SPPCO OR SPPFA.
C
C     ON ENTRY
C
C         AP      REAL (N*(N+1)/2)
C                 THE OUTPUT FROM SPPCO OR SPPFA.
C
C         N       INTEGER
C                 THE ORDER OF THE MATRIX A .
C
C         B       REAL (N)
C                 THE RIGHT HAND SIDE VECTOR.
C
C     ON RETURN
C
C         B       THE SOLUTION VECTOR X .
C
C     ERROR CONDITION
C
C         A DIVISION BY ZERO WILL OCCUR IF THE INPUT FACTOR CONTAINS
C         A ZERO ON THE DIAGONAL.  TECHNICALLY THIS INDICATES
C         SINGULARITY BUT IT IS USUALLY CAUSED BY IMPROPER SUBROUTINE
C         ARGUMENTS.  IT WILL NOT OCCUR IF THE SUBROUTINES ARE CALLED
C         CORRECTLY AND INFO .EQ. 0 .
C
C     TO COMPUTE INVERSE(A) * C WHERE C IS A MATRIX
C     WITH P COLUMNS
C         CALL SPPCO(AP,N,RCOND,2,INFO)
C         IF (RCOND IS TOO SMALL .OR. INFO .NE. 0) GO TO ...
C         DO 10 J = 1, P
C           CALL SPPSL(AP,N,C(1,J))
C         10 CONTINUE
C
C     LINPACK.  THIS VERSION DATED 08/14/78 .
C     CLEVE MOLER, UNIVERSITY OF NEW MEXICO, ARGONNE NATIONAL LAB.
C
C     SUBROUTINES AND FUNCTIONS
C
C     BLAS SAXPY,SDOT
C
C     INTERNAL VARIABLES
C
C     REAL SDOT,T
C     INTEGER K,KB,KK
C
C     KK = 0
C     DO 10 K = 1, N
C       T = SDOT(K-1,AP(KK+1),1,B(1),1)
C       KK = KK + K
C       B(K) = (B(K) - T)/AP(KK)
10    CONTINUE
      DO 20 KB = 1, N
        K = N + 1 - KB
        B(K) = B(K)/AP(KK)
        KK = KK - K
        T = -B(K)
        CALL SAXPY(K-1,T,AP(KK+1),1,B(1),1)
20    CONTINUE
      RETURN
      END

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0.3280000000000D+03 0.2733570669084D+00  
0.3290000000000D+03 0.2719773827742D+00  
0.3300000000000D+03 0.2706004940049D+00  
0.3310000000000D+03 0.2692264287584D+00  
0.3320000000000D+03 0.2678552149196D+00  
0.3330000000000D+03 0.2664868801002D+00  
0.3340000000000D+03 0.2651214516384D+00  
0.3350000000000D+03 0.2637589565986D+00  
0.3360000000000D+03 0.2623994217710D+00  
0.3370000000000D+03 0.2610428736716D+00  
0.3380000000000D+03 0.2596893385417D+00  
0.3390000000000D+03 0.2583388423481D+00  
0.3400000000000D+03 0.2569914107826D+00  
0.3410000000000D+03 0.2556470692618D+00  
0.3420000000000D+03 0.2543058429273D+00  
0.3430000000000D+03 0.2529677566454D+00  
0.3440000000000D+03 0.2516328350070D+00  
0.3450000000000D+03 0.2503011023275D+00  
0.3460000000000D+03 0.2489725826471D+00  
0.3470000000000D+03 0.2476472997301D+00  
0.3480000000000D+03 0.2463252770656D+00  
0.3490000000000D+03 0.2450065378672D+00  
0.3500000000000D+03 0.2436911050730D+00  
0.3510000000000D+03 0.2423790013459D+00  
0.3520000000000D+03 0.2410702490733D+00  
0.3530000000000D+03 0.2397648703675D+00  
0.3540000000000D+03 0.2384628870660D+00  
0.3550000000000D+03 0.2371643207312D+00  
0.3560000000000D+03 0.2358691926507D+00  
0.3570000000000D+03 0.2345775238377D+00  
0.3580000000000D+03 0.2332893350312D+00  
0.3590000000000D+03 0.2320046466958D+00

0.3600000000000000+03 0.2307234790226D+00  
 0.3610000000000000+03 0.2294458519287D+00  
 0.3620000000000000+03 0.2281717850583D+00  
 0.3630000000000000+03 0.2269012977824D+00  
 0.3640000000000000+03 0.2256344091995D+00  
 0.3650000000000000+03 0.2243711381355D+00  
 0.3660000000000000+03 0.2231115031446D+00  
 0.3670000000000000+03 0.2218555252093D+00  
 0.3680000000000000+03 0.2206032142411D+00  
 0.3690000000000000+03 0.2193545960805D+00  
 0.3700000000000000+03 0.2181096854979D+00  
 0.3710000000000000+03 0.2168684996937D+00  
 0.3720000000000000+03 0.2156310555991D+00  
 0.3730000000000000+03 0.2143973698761D+00  
 0.3740000000000000+03 0.2131674589188D+00  
 0.3750000000000000+03 0.2119413388529D+00  
 0.3760000000000000+03 0.2107190255372D+00  
 0.3770000000000000+03 0.2095005345637D+00  
 0.3780000000000000+03 0.2082858812580D+00  
 0.3790000000000000+03 0.2070750806805D+00  
 0.3800000000000000+03 0.2058681476263D+00  
 0.3810000000000000+03 0.2046650966265D+00  
 0.3820000000000000+03 0.2034659419483D+00  
 0.3830000000000000+03 0.2022706975959D+00  
 0.3840000000000000+03 0.2010793773114D+00  
 0.3850000000000000+03 0.1998919945751D+00  
 0.3860000000000000+03 0.1987085626064D+00  
 0.3870000000000000+03 0.1975290943646D+00  
 0.3880000000000000+03 0.1963536025493D+00  
 0.3890000000000000+03 0.1951820996018D+00  
 0.3900000000000000+03 0.1940145977053D+00  
 0.3910000000000000+03 0.1928511087858D+00  
 0.3920000000000000+03 0.1916916445132D+00  
 0.3930000000000000+03 0.1905362163017D+00  
 0.3940000000000000+03 0.1893848353110D+00  
 0.3950000000000000+03 0.1882375124469D+00  
 0.3960000000000000+03 0.1870942583623D+00  
 0.3970000000000000+03 0.1859550834580D+00  
 0.3980000000000000+03 0.1848199978838D+00  
 0.3990000000000000+03 0.1836890115390D+00  
 0.4000000000000000+03 0.1825621340737D+00  
 0.4010000000000000+03 0.1814393748894D+00  
 0.4020000000000000+03 0.1803207431405D+00  
 0.4030000000000000+03 0.1792062477344D+00  
 0.4040000000000000+03 0.1780958973335D+00  
 0.4050000000000000+03 0.1769897003552D+00  
 0.4060000000000000+03 0.1758876649737D+00  
 0.4070000000000000+03 0.1747897991203D+00  
 0.4080000000000000+03 0.1736961104851D+00  
 0.4090000000000000+03 0.1726066065177D+00  
 0.4100000000000000+03 0.1715212944279D+00  
 0.4110000000000000+03 0.1704401811876D+00  
 0.4120000000000000+03 0.1693632735311D+00  
 0.4130000000000000+03 0.1682905779566D+00  
 0.4140000000000000+03 0.1672221007272D+00  
 0.4150000000000000+03 0.1661578478718D+00  
 0.4160000000000000+03 0.1650978251865D+00  
 0.4170000000000000+03 0.1640420382357D+00  
 0.4180000000000000+03 0.1629904923530D+00  
 0.4190000000000000+03 0.1619431926426D+00  
 0.4200000000000000+03 0.1609001439804D+00  
 0.4210000000000000+03 0.1598613510150D+00  
 0.4220000000000000+03 0.1588268181691D+00  
 0.4230000000000000+03 0.1577965496405D+00  
 0.4240000000000000+03 0.1567705494036D+00  
 0.4250000000000000+03 0.1557488212101D+00  
 0.4260000000000000+03 0.1547313685907D+00  
 0.4270000000000000+03 0.1537181948561D+00  
 0.4280000000000000+03 0.1527093030982D+00  
 0.4290000000000000+03 0.1517046961917D+00  
 0.4300000000000000+03 0.1507043767946D+00  
 0.4310000000000000+03 0.1497083473503D+00  
 0.4320000000000000+03 0.1487166100883D+00  
 0.4330000000000000+03 0.1477291670257D+00  
 0.4340000000000000+03 0.1467460199685D+00  
 0.4350000000000000+03 0.1457671705128D+00  
 0.4360000000000000+03 0.1447926200462D+00  
 0.4370000000000000+03 0.1438223697489D+00  
 0.4380000000000000+03 0.1428564205954D+00  
 0.4390000000000000+03 0.1418947733552D+00  
 0.4400000000000000+03 0.1409374285949D+00  
 0.4410000000000000+03 0.1399843866790D+00  
 0.4420000000000000+03 0.1390356477712D+00  
 0.4430000000000000+03 0.1380912118362D+00  
 0.4440000000000000+03 0.1371510786406D+00  
 0.4450000000000000+03 0.1362152477545D+00  
 0.4460000000000000+03 0.1352837185528D+00  
 0.4470000000000000+03 0.1343564902166D+00  
 0.4480000000000000+03 0.1334335617344D+00  
 0.4490000000000000+03 0.1325149319039D+00

0.450000000000D+03 0.1316005993328D+00  
 0.451000000000D+03 0.1306905624408D+00  
 0.452000000000D+03 0.1297848194604D+00  
 0.453000000000D+03 0.1288833684389D+00  
 0.454000000000D+03 0.1279862072394D+00  
 0.455000000000D+03 0.1270933335422D+00  
 0.456000000000D+03 0.1262047448465D+00  
 0.457000000000D+03 0.1253204384716D+00  
 0.458000000000D+03 0.1244404115582D+00  
 0.459000000000D+03 0.1235646610704D+00  
 0.460000000000D+03 0.1226931837962D+00  
 0.461000000000D+03 0.1218259763500D+00  
 0.462000000000D+03 0.1209630351731D+00  
 0.463000000000D+03 0.1201043565357D+00  
 0.464000000000D+03 0.1192499365382D+00  
 0.465000000000D+03 0.1183997711125D+00  
 0.466000000000D+03 0.1175538560237D+00  
 0.467000000000D+03 0.1167121868713D+00  
 0.468000000000D+03 0.1158747590909D+00  
 0.469000000000D+03 0.1150415679556D+00  
 0.470000000000D+03 0.1142126085770D+00  
 0.471000000000D+03 0.1133878759075D+00  
 0.472000000000D+03 0.1125673647410D+00  
 0.473000000000D+03 0.1117510697147D+00  
 0.474000000000D+03 0.1109389853108D+00  
 0.475000000000D+03 0.1101311058574D+00  
 0.476000000000D+03 0.1093274255303D+00  
 0.477000000000D+03 0.1085279383544D+00  
 0.478000000000D+03 0.1077326382055D+00  
 0.479000000000D+03 0.1069415188111D+00  
 0.480000000000D+03 0.1061545737523D+00  
 0.481000000000D+03 0.1053717964654D+00  
 0.482000000000D+03 0.1045931802429D+00  
 0.483000000000D+03 0.1038187182355D+00  
 0.484000000000D+03 0.1030484034532D+00  
 0.485000000000D+03 0.1022822287667D+00  
 0.486000000000D+03 0.1015201869094D+00  
 0.487000000000D+03 0.1007622704782D+00  
 0.488000000000D+03 0.1000084719356D+00  
 0.489000000000D+03 0.9925878361054D-01  
 0.490000000000D+03 0.9851319770041D-01  
 0.491000000000D+03 0.9777170627220D-01  
 0.492000000000D+03 0.9703430126409D-01  
 0.493000000000D+03 0.9630097448686D-01  
 0.494000000000D+03 0.9557171762539D-01  
 0.495000000000D+03 0.9484652224011D-01  
 0.496000000000D+03 0.9412537976844D-01  
 0.497000000000D+03 0.9340828152630D-01  
 0.498000000000D+03 0.9269521870950D-01  
 0.499000000000D+03 0.9198618239525D-01



## **APPENDIX D: STATISTICS AND DATA CONVERSIONS**

### **D.1 CHECK**

**Check** is used for quickly defining the basic statistics (minimum, maximum, average, difference between adjacent points and variance) of an individual pass. If any one of the parameters is outside of the acceptable limits, then the pass number and all parameters are written to the screen. Rerunning this program several times while varying the cutoff limits helps to assess the general quality of the input data.

### **D.2 STATMAT**

This program finds the standard statistics of any of the grids of Chapter III. If more than one grid is input, then the correlation coefficients between all possible map-to-map comparisons are also found. **Statmat** should be used to determine the similarities and differences between dawn and dusk maps and between continued maps.

### **D.3 PART2**

This program was written by Dr. Gary P. Murdock and is used to convert the three Investigator-B tapes supplied by NASA on an IBM platform to a Digital Equipment Corporation (DEC) platform. The program converts IBM text and fixed point and floating point numbers to their respective representation on the DEC machine. Similar code can be written to convert IBM values to other platforms.

```

program check
real*4 mean,maxval,minval,diff,maxdiff,total,
> maxmax,minmin,meanmax,diffmax,dummy,xmean,maxvar
double precision passord(4000,2),ra(4000)
character*80 filename
character*4 choice,test
dimension idata(1500,2),data(1500,27)
integer*4 count,var,countall,type,row,col,zero,pass,eight,
> recnum,passnum(4000),passmjd(4000,2)
common /hsort/ ra

c
c----- program description
c
c   check locates all passes with a minimum below a user defined
c   value, a maximum above a user defined value, a variance above
c   a user defined maximum, a mean value beyond a user defined value
c   and a difference between adjacent observations greater than a
c   user defined value.  if a pass is selected, then the pass number
c   and the above values are written to the screen.  this program
c   can be used on direct access 21-27r files or on files with a
c   header and one variable per pass.  this program is used to find
c   passes which are influenced by external fields as noted by
c   their variance properties.
c
c   program date: 22 apr 91
c
c   updates: 6 jun 92; added sort subroutine
c   NOTE: check now removes the checked passes (ie. the high
c   variance passes) from the ordered pass number file
c   written by reorder.
c   NOTE: now check also orders the output file according to
c   the average elevation of the pass.
c   NOTE: these new options are not available for 21-27r input.
c   20 jul 92; added output file on unit 21
c   NOTE: this update simplifies the useage of check
c
c
c   write (*,*) '0 IF INPUT FILE IS 21-27R'
c   write (*,*) '1 IF INPUT FILE IS HEADER AND VARIABLE'
c   read (*,*) type
c   if (type) 50,50,200
c
c 50   write (*,*) 'INPUT 21-27R FILE:'
c   read (*,9990) filename
c 9990 format (a80)
c   open (10, file=filename, status='old',form='unformatted',
c   > access='direct',recl=116)
c----- recl=29 for a dec3100
c   write (*,*) 'WHICH VARIABLE DO YOU WANT FROM THE 27'
c   write (*,*) 'lat lon rad mlt invlat diplat bs bv x y z'
c   write (*,*) 'bva xa ya za totfld xfld yfld zfld inc dec'
c   write (*,*) 'totmag totavgmag resid resavgmag ringcur sec'
c   read (*,*) var
c   write (*,*) 'MAXIMUM ABSOLUTE VALUE FOR MEAN WITHOUT TELLING YOU'
c   write (*,*) 'MAXIMUM VALUE FOR DIFFERENCE'
c   write (*,*) 'MAXIMUM VALUE FOR VARIABLE'
c   write (*,*) 'MINIMUM VALUE FOR VARIABLE'
c   write (*,*) 'MAXIMUM VARIANCE FOR VARIABLE'
c   read (*,*) meanmax,diffmax,maxmax,minmin,maxvar
c
c   write (*,*) 'PASSNO CNT      MAX      MEAN      MIN',
c   >      ,      DIFF      MAXVAR'
c
c 21   jstop=0
c   recnum=1
c   countall=0
c   count=0
c   read (10,rec=recnum) (idata(1,1),i=1,2), (data(1,j), j=1,27)
c 22   n=2
c 23   recnum=recnum+1
c   read (10,rec=recnum,err=24) (idata(n,1),i=1,2), (data(n,j), j=1,27)
c   if (idata(n,1) .ne. idata(n-1,1)) go to 25
c   n=n+1
c   go to 23
c 24   continue
c   jstop=1
c 25   continue
c
c   countall=countall+1
c   total=0.0
c   xsumsq=0.0
c   maxval=-10e10
c   minval=10e10
c   maxdiff=10e-10
c   dummy=data(n,var)
c   data(n,var)=data(n-1,var)
c   do 100 i=1,n-1
c     total=total+data(i,var)
c     xsumsq=xsumsq+(data(i,var)**2)
c     maxval=max(maxval,data(i,var))

```

```

        minval=min(minval,data(i,var))
        diff=data(i,var)-data(i+1,var)
        maxdiff=max(maxdiff,abs(diff))
100 continue
    mean=total/(n-1)
    xvar=(xsumsqr-(((total)**2)/real(n-1)))/real(n-2)
    absmean=abs(mean)
    if (absmean.gt.meanmax .or. maxval.gt.maxmax .or.
> minval.lt.minmin .or. maxdiff.gt.diffmax .or.
> xvar.gt.maxvar) then
        write (*,9992) idata(n-1,1),n-1,maxval,mean,minval,
> maxdiff,xvar
9992 format (2i5,5(1x,f12.6))
        count=count+1
    endif
    data(n,var)=dummy
c
27 continue
    do 28 i=1,2
        idata(1,i)=idata(n,i)
28 continue
    do 29 j=1,27
        data(i,j)=data(n,j)
29 continue
    if (jstop .eq. 1) go to 999
    go to 22
c
200 continue
    countall=0
    count=0
    write (*,*) 'INPUT HEADER AND ONE VARIABLE FILE:'
    read (*,9990) filename
    open (10, file=filename, status='old',form='unformatted')
    write (*,*) '1 to work with magnetic variable or latitude'
    write (*,*) '2 to work with longitude'
    write (*,*) '3 to work with radius'
    read (*,*) var
    write (*,*) 'MAXIMUM ABSOLUTE VALUE FOR MEAN WITHOUT TELLING YOU'
    write (*,*) 'MAXIMUM VALUE FOR DIFFERENCE'
    write (*,*) 'MAXIMUM VALUE FOR VARIABLE'
    write (*,*) 'MINIMUM VALUE FOR VARIABLE'
    write (*,*) 'MAXIMUM VALUE FOR VARIANCE'
    read (*,*) meanmax,diffmax,maxmax,minmin,maxvar
    write (*,*) 'REMOVE THESE PASSES FROM THE ORDERED PASS FILE'
    write (*,*) 'yes OR no (choose yes after running several times'
    write (*,*) ' to determine the variance cutoff)'
    read (*,9991) choice
9991 format (a4)
    if (choice.eq.'yes' .or. choice.eq.'YES') then
        write (*,*) 'INPUT FILE OF ORDERED PASS NUMBERS'
        read (*,9990) filename
        open (11, file=filename,form='formatted',status='old')
        write (*,*) 'OUTPUT FILE = PASS NUMBERS - CHECKED NUMBERS'
        read (*,9990) filename
        open (20, file=filename,form='formatted')
        icnt=0
        do i=1,10000
            read (11,9991) test
            icnt=icnt+1
            if (test .eq. ' new') then
                read (11,9991) test
                go to 205
            end if
        end do
205 icnt=icnt-2
        write (*,*) 'read ',icnt,' passes from pass file'
        write (*,*) 'OUTPUT FILE OF CHECKED PASSES'
        read (*,9990) filename
        open (21, file=filename,form='formatted')
c
        do i=1,icnt
            read (11,*) (passmjd(i,j),j=1,2),(passord(i,j),j=1,2)
        end do
    endif
c
    write (*,*) 'PASSNO CNT      MAX      MEAN      MIN',
>      '      DIFF MAXVAR'
c
210 read (10,end=500) row,col,zero,xmean,pass,eight
    do 220 i=1,row
        read (10) (data(i,j),j=1,col)
220 continue
    countall=countall+1
    total=0.0
    xsumsqr=0.0
    maxval=-10e10
    minval=10e10
    maxdiff=10e-10
    data(row+1,var)=data(row,var)

```

```

do 240 i=1,row
  total=total+data(i,var)
  xsumsq=xsumsq+(data(i,var)**2)
  maxval=max(maxval,data(i,var))
  minval=min(minval,data(i,var))
  diff=data(i,var)-data(i+1,var)
  maxdiff=max(maxdiff,abs(diff))
240 continue
mean=total/row
xvar=(xsumsq-((total)**2)/real(row))/real(row-1)
absmean=abs(mean)
if (absmean.gt.meanmax .or. maxval.gt.maxmax .or.
> minval.lt.minmin .or. maxdiff.gt.diffmax .or.
> xvar.gt.maxvar) then
c
  write (*,9992) pass,row,maxval,mean,minval,maxdiff,xvar
  if (choice.eq.'yes' .or. choice.eq.'YES')
  > write (21,9992) pass,row,maxval,mean,minval,maxdiff,xvar
c
  count=count+1
  passnum(count)=pass
endif
go to 210
c
500 continue
if (choice.eq.'yes' .or. choice.eq.'YES') then
  jcnt=0
  do i=1,icnt
    do j=1,count
      if (passmjd(i,1) .eq. passnum(j)) go to 510
    enddo
    jcnt=jcnt+1
    ra(jcnt)=passord(i,2)
510 continue
  enddo
c
  call sort (jcnt)
c
  do i=1,jcnt
    do j=1,icnt
      if ( ra(i) .eq. passord(j,2) ) then
        write (20,*) (passmjd(j,jj),jj=1,2),passord(j,1),
        > real(passord(j,2))
        go to 520
      endif
    enddo
520 continue
  enddo
endif
999 continue
close (10)
close (11)
close (20)
write (*,*) 'total passes counted = ',countall
write (*,*) 'total passes checked = ',count
write (*,*) 'total passes written to file = ',jcnt
stop
end

c
c
SUBROUTINE SORT(N)
double precision ra,rra
common /hsort/ ra(4000)
c-----this subroutine is written by the authors
c of: Numerical Recipes (fortran);
c The Art of Scientific Computing
c Cambridge University Press
c 1989, p. 230
c the routine is referred to as "heapsort"
c Copyright (C) 1986, 1992 Numerical Recipes Software
c
  L=N/2+1
  IR=N
100 CONTINUE
  IF (L.GT.1) THEN
    L=L-1
    RRA=RA(L)
  ELSE
    RRA=RA(IR)
    RA(IR)=RA(1)
    IR=IR-1
    IF (IR.EQ.1) THEN
      RA(1)=RRA
      RETURN
    ENDIF
  ENDIF
  I=L
  J=L+L
200 IF (J.LE.IR) THEN
    IF (J.LT.IR) THEN

```

```

        IF (RA (J) . LT. RA (J+1) ) J=J+1
    ENDIF
    IF (RRA . LT. RA (J) ) THEN
        RA (I) =RA (J)
        I=J
        J=J+J
    ELSE
        J=IR+1
    ENDIF
    GO TO 200
ENDIF
RA (I) =RRA
GO TO 100
END

```



```

      program statmat
      character*70 filename(5),statfile
      character*5 done
      integer*4 col(5),row(5),count
      real*4 nobss,data(500,500,5),colat(5),long(5),space(5),
>      xmean,ymean
      dimension xdata(250000),ydata(250000)

c-----
c----- program description
c      statmat defines the basic statistics of the input grids.  see
c      the write statements for the specific values calculated.  also,
c      the code loops through all input grids and calculates the
c      correlation coefficients between all combinations of input
c      data.
c
c      write (*,*) 'OUTPUT STATISTICS FILE'
c      read (*,9990) statfile
c      open (25, file=statfile, form='formatted')

c-----
c-----read all data into array (row,col,layer or map number)
      i=1
10      write (*,*) 'INPUT MATRIX WITH TPLOT HEADER'
      read (*,9990) filename(i)
      9990 format (a70)
      open (10, file=filename(i),status='old',form='formatted')

c
      read (10,*) col(i)
      read (10,*) row(i)
      read (10,*) colat(i)
      read (10,*) long(i)
      read (10,*) space(i)
      read (10,*) ((data(j,k,i),k=1,col(i)),j=1,row(i))
      close (10)
      write (*,*) 'ARE YOU THROUGH YET???'
      read (*,9991) done
      9991 format (a5)
      if (done .eq. 'y' .or. done .eq. 'yes') go to 50
      i=i+1
      go to 10

c-----
c-----maximum number of input data sets =count
c      loops from line 80 to 400 increment through all
c      maps comparing all possible logical
c      combinations of map to map
      50      count=1
      write (*,*) 'total number of input data sets =',count
      do 60 i=1,count-1
        if (col(i) .ne. col(i+1) .or. row(i) .ne. row(i+1)) then
          write (*,*) filename(i),col(i),row(i)
          write (*,*) filename(i),col(i),row(i)
          write (*,*) 'rows or columns do not match'
          stop 0001
        endif
      60      continue

c-----
c-----from 200 to write statement of variables is
c      the statistical calculations using two
c      references:
c      1) Davis, Statistics and Data Analysis in
c      Geology, 2nd ed., 1986 pp. 41
c      2) Young, Statistical Treatment of Experi-
c      mental Data, 1962, McGraw Hill, 115-132
c
      80      continue
      do 400 icnt=1,count
        do 400 jcnt=1,count

c
          do 100 j=1,row(icnt)
            do 100 k=1,col(icnt)
              ij=(col(icnt)*(j-1))+k
              xdata(ij)=data(j,k,icnt)
              ydata(ij)=data(j,k,jcnt)

100          continue

c-----
c-----loops that sum x, x**2, y, y**2 and xy
      nobss=row(icnt)*col(icnt)
      if (nobss .ne. 1) stop 0002
      nobss=float(nobss)
      xsum=0.0
      xsumsq=0.0
      ysum=0.0
      ysumsq=0.0
      sumxy=0.0
      xmax=xdata(1)
      xmin=xmax
      ymax=ydata(1)
      ymin=ymax
      do 240 j4=1,nobss
        xsum=xsum+xdata(j4)
        xsumsq=xsumsq+(xdata(j4))**2
        ysum=ysum+ydata(j4)

```

```

        ysumsq=ysumsqr+(ydata(j4))**2
        sumxy=sumxy+(xdata(j4)*ydata(j4))
        xmax=max(xmax,xdata(j4))
        xmin=min(xmin,xdata(j4))
        ymax=max(ymax,ydata(j4))
        ymin=min(ymin,ydata(j4))
240  continue
c-----find corrected sum of products, covariance
c      and corrected sum of squares (x) (y)
c
        xmean=xsum/nobss
        ymean=ysum/nobss
        sumprod=sumxy-((xsum*ysum)/nobss)
        covarxy=sumprod/(nobss-1.0)
        xcsumsq=xsumsq-((xsum**2)/nobss)
        ycsumsq=ysumsqr-((ysum**2)/nobss)
c
c-----find variance, standard deviation for x and y
c
        xvar=xcsumsq/(nobss-1.0)
        yvar=ycsumsq/(nobss-1.0)
        xstdev=sqrt(xvar)
        ystdev=sqrt(yvar)
c-----find correlation coefficient by Davis method
        corrDxy=covarxy/(xstdev*ystdev)
c-----find slopes, intercepts and correlation
c      coefficient by Young method
        xslope=((nobss*sumxy)-(xsum*ysum))/((nobss*xsumsq)-xsum**2)
        yslope=((nobss*sumxy)-(xsum*ysum))/((nobss*ysumsqr)-ysum**2)
        xintcpt=((ysum*xsumsq)-(sumxy*xsum))/((nobss*xsumsq)-xsum**2)
        yintcpt=((xsum*ysumsqr)-(sumxy*ysum))/((nobss*ysumsqr)-ysum**2)
        corrYxy=sqrt(xslope*yslope)
c
c-----write out this mess for individual pass and
c      overlapping lengths of passes
c
        write (25,*) 'X = ',filename(1cnt)
        write (25,*) 'Y = ',filename(jcnt)
        write (25,9992) xmean,ymean,xvar,yvar,xstdev,ystdev
9992 format('X MEAN =',f9.3,' Y MEAN =',f9.3,/,
>         'X VARIANCE=',f9.1,' Y VARIANCE=',f9.1,' X STDEV=',
>         f8.3,' Y STDEV=',f8.3)
        write (25,9993) covarxy,corrDxy
9993 format('COVARIANCE XY=',f9.1,' Davis CORRELATION COEF=',f8.3)
        write (25,9994) xslope,xintcpt,yslope,yintcpt,corrYxy
9994 format('X SLOPE=',f8.3,' X INTERCEPT=',f8.3,' Y SLOPE=',
>         f8.3,' Y INTERCEPT=',f8.3,/, 'Young CORRELATION COEF=',
>         f8.3,)
        write (25,9995) xmax,xmin,ymax,ymin
        write (*,*) corrDxy
9995 format('X-MAX=',f9.3,' X-MIN=',f9.3,' Y-MAX=',f9.3,
>         ' Y-MIN=',f9.3,/)
c
c
c-----increment to next set of passes
400  continue
c
999  continue
      close (10)
      close (25)
      stop
      end

```





```

      program part2
c
c----- convert magsat text from ebcdic to ascii, reorder integer bytes,
c----- and translate ibm real to dec real
c
c      editorial note: this code was supplied quite generously by Dr. Gary P.
c                      Murdock
c
c      implicit none
c
c----- parameter storage:
      integer reclen
      parameter (reclen=3024)
c
c----- common storage:
      character*1 ascconv(256)
      common /e2acom/ ascconv
      integer*4 recnum,position
      common /xxyyzz/recnum,position
c
c----- equivalence storage:
      integer*4 inbufi(reclen/4),outbufi(reclen/4)
      character*1 inbufc(reclen),outbufc(reclen)
      equivalence (inbufi,inbufc),(outbufi,outbufc)
c
c----- local storage:
      integer i1,i2
      character*80 filename
      character*1 cl
c
c----- data: (0=no translate, 1=real*4, 2=integer*4, 3=ebcdic)
      integer*2 headtyp(557) /4*2,4*1,2*2,4*1,2*2,6*0,12*1,30*3,3*2,
      > 490*1/
      integer*2 datatyp(756) /5*2,691*1,30*2,30*0/
c
c----- functions:
      integer*4 realconv
c
c----- constants:
      cl = char(1)
c
      write (*,*) 'input file:'
      read (*,99901) filename
99901 format (a80)
      open (21,file=filename,status='old',
      > access='direct',form='formatted',recl=reclen)
      write (*,*) 'output file:'
      read (*,99901) filename
      open (31,file=filename,
      > access='direct',form='formatted',recl=reclen)
c
      recnum = 1
100  read (21,92101,rec=recnum,err=200) inbufc
92101 format (50000a)
      if (inbufc(4).eq.cl) then
        do position = 1,557
          goto (104,101,102,103),headtyp(position)+1
101      outbufi(position) = realconv(inbufi(position))
          goto 104
102      i1 = position*4
          outbufc(i1-3) = inbufc(i1)
          outbufc(i1-2) = inbufc(i1-1)
          outbufc(i1-1) = inbufc(i1-2)
          outbufc(i1) = inbufc(i1-3)
          goto 104
103      i1 = position*4
          do i2 = i1-3,i1
            outbufc(i2) = ascconv(ichar(inbufc(i2))+1)
          end do
104      end do
      else
        do position = 1,756
          goto (108,105,106,107),datatyp(position)+1
105      outbufi(position) = realconv(inbufi(position))
          goto 108
106      i1 = position*4
          outbufc(i1-3) = inbufc(i1)
          outbufc(i1-2) = inbufc(i1-1)
          outbufc(i1-1) = inbufc(i1-2)
          outbufc(i1) = inbufc(i1-3)
          goto 108
107      i1 = position*4
          do i2 = i1-3,i1
            outbufc(i2) = ascconv(ichar(inbufc(i2))+1)
          end do
108      end do
      end if
      write (31,92101,rec=recnum) outbufc
      recnum = recnum+1
      goto 100

```

```

c
200 stop
end

BLOCK DATA EBC2ASC
INTEGER*4 LOOKUP(64) /
> 50462976, 2139490716, 193891735, 252579084, 319951120,
> -2029484643, -1886250728, 522067228, -2088599168, 454494852,
> -1953855096, 117835148, -1827237488, 76977556, -1684366952,
> 446567700, -1566466016, -1499093853, 777758887, 556476476,
> -1414878938, -1347506772, 610120112, 1580935466, -1280168147,
> -1212762700, 746371512, 1061052197, -1111704646, -1044332610,
> 591028418, 574433088, 1667391939, 1734763876, -976983704,
> -909588538, 1818979018, 1886350957, -859082127, -791687475,
> 1953726161, 2021095029, -741180807, -673786412, -606414376,
> -539042340, -471670304, -404298268, 1128415611, 1195787588,
> -370652856, -303240214, 1280002685, 1347374669, -269594031,
> -202182160, 1414766428, 1482118741, -168535463, -101124106,
> 858927408, 926299444, -67487432, -66052 /
COMMON /E2ACOM/ LOOKUP
END

INTEGER*4 FUNCTION REALCONV (IBM)
C
IMPLICIT NONE
C
C----- DUMMY STORAGE:
INTEGER*4 IBM
C
C----- EQUIVALENCE STORAGE:
INTEGER*4 IIBM
CHARACTER*1 CIBM(4)
EQUIVALENCE (IIBM,CIBM)
INTEGER*4 IDEC
CHARACTER*1 CDEC(4)
EQUIVALENCE (IDEC,CDEC)
C
C----- common storage:
integer*4 recnum,position
common /xyyyzz/recnum,position
C
C----- LOCAL STORAGE:
INTEGER COUNT
LOGICAL SIGNFLAG
CHARACTER*1 CO
C
C----- "CONSTANTS"
CO = CHAR(0)
C
C----- MOVE ARGUMENT TO EQUIVALENCE AREA
IIBM = IBM
C
C----- SWITCH MANTISSA BYTES INTO dec
CDEC(1) = CIBM(4)
CDEC(2) = CIBM(3)
CDEC(3) = CIBM(2)
C
C----- ZERO NON-MANTISSA BYTE
CDEC(4) = CO
C
C----- CHECK FOR 0.0
IF (CDEC(1).EQ.CO .AND. CDEC(2).EQ.CO .AND. CDEC(3).EQ.CO)
> GOTO 120
C----- SHIFT MANTISSA BITS LEFT UNTIL A 1 IS FOUND, DISCARD THE 1,
C----- KEEP COUNT
COUNT = 0
100 IDEC = ISHFT(IDEC,1)
IF (CDEC(4).NE.CO) GOTO 110
COUNT = COUNT+1
GOTO 100
C
C----- EXTRACT AND CLEAR SIGN BIT
110 SIGNFLAG = BTEST(IIBM,7)
IIBM = IBCLR(IIBM,7)
C
C----- CALCULATE NEW EXPONENT
CIBM(2) = CO
CIBM(3) = CO
CIBM(4) = CO
IIBM = IIBM*4-COUNT-130
IF (IIBM.GT.255 .OR. IIBM.LT.0) THEN
write (*,99901) recnum,position
99901 format ('ibm value out of range in',i6,',',i3)
cdec(1) = c0
cdec(2) = c0
cdec(3) = c0
cdec(4) = c0
goto 120
END IF

```

```

C
C---- MERGE DEC SIGN, EXPONENT AND MANTISSA
      CDEC(4) = CIBM(1)
      IDEC = ISHFT(IDEC,-1)
      IF (SIGNFLAG) IDEC = IBSET(IDEC,31)
C
120  REALCONV = IDEC
      RETURN
      END

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